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STRATOVOLCANO MODEL/GEOTHERMAL SYSTEMS

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ABSTRACT

Subvolcanic stocks under stratovolcanos are typically 1 to 3 km in diameter and emplaced at depths of 1 to 4 km. Exposed stocks in the Western Cascades of Oregon are of similar size and were emplaced at depths of 1 to 2 km. Shallow magma chambers in general are typically 4 to 9 km deep, and several times larger than the subvolcanic stocks.

Likely subvolcanic structures are radial compression fractures around the magma chamber, and above the chamber extension faulting, stockwork fractures and breccia pipes. Pre-existing or regional structures may affect magma emplacement and associated thermal systems.

A geothermal system may occur at depths of 1-2 km under a stratocone's base. Deeper systems associated with shallow magma chambers are likely to be present.

INTRODUCTION

A concise model of the feeder system of a Cascades Stratovolcano is needed to formulate geothermal exploration strategies and interpret drilling and geophysical data. Several studies of Cascade geothermal systems are available (Wollenberg, et al., 1979; Muffler et al., 1982; Sammel, 1983) but these studies focus primarily on the temperature and chemistry of geothermal systems at relatively shallow depths. They do not deal with the deeper configuration of intrusions, faults, permeability and alteration controlling the geothermal system and how these factors may relate to geophysical data. Volcano models proposed for Australasia (Branch, 1976) and stratovolcanos in the Andes (Francis et al., 1983) do not specifically consider geothermal systems, the models' applicability to Cascades volcanos is uncertain. This study focuses on structures between the base of the cone and the shallow magma chamber below, with emphasis on factors which affect a geothermal system or exploration for it.

A four-component study was undertaken to compile the data base for the Cascade volcano model. First a general literature review was made for case examples of stratovolcano substructures, volcano models and reported depth and size of the related shallow magma or intrusions. The second component was a limited review of thermal systems which produced mineralization in a volcanic setting as an analog to active geothermal systems. Both of these

studies targeted primarily Circum-Pacific, continental edge stratovolcanos because of the similarity to the Cascades setting. Because the Cascades are primarily stratovolcanos, the vast literature available on calderas was not reviewed, however some data on Valles and Long Valley calderas are presented for comparison with those at Newberry and Medicine Lake. The objective of the literature review was to determine the typical depth and size of magma chambers, structures and hydrothermal systems associated with stratovolcanos for comparison with the Cascades volcanos and was not intended to be an exhaustive review of all the literature.

The third component of the study was a reconnaissance study of stocks and mineralized districts in the Western Cascades as an indication of what are the subsurface characteristics of Cascade volcanos. The fourth component was a study of available data on the high Cascades volcanos.

DEPTH AND SIZE OF SUBVOLCANIC INTRUSIONS

Circum-Pacific Examples

The probable depth and size of a magma chamber or intrusions associated with a volcano is important in geothermal exploration because the depth, size and reservoir rocks of the hydrothermal system will be related to the heat source. These parameters will influence the cost and type of exploration techniques and the potential value of the resource. Reliable estimates of depth and

size of existing magma chambers are limited and based primarily on geophysical data, but a few estimates have been based on heat flow and structural considerations. Depth of emplacement of intrusions associated with mineralization has been determined by fluid inclusion studies and in a few rare cases on stratigraphic and structural reconstruction. Generally, however, when erosion has cut deep enough to expose a pluton or make associated mineralization accessible to mining, the related volcanic pile has been stripped away, leaving correlation between pluton and associated volcanic structures uncertain.

The depths and sizes of several magma chambers are listed in table 1. The first two are models based on several active volcanos (Branch, 1976) or studies of ore deposits under extinct volcanos (Francis et al., 1983), and represent many examples. Also, the study by Latter (1981) includes several New Zealand volcanos. Although the reported depths of active magma chambers have a wide range, the data suggest that the tops of magma chambers are typically 2 to 6 km deep. Some depths are measured from a volcano's summit and some from its base, and the authors don't always specify which. A few magma chambers occur below 9 km. The deep magma chambers, 30 km or more, are probably at or near the source area. Shallow magma chambers have not been detected under many active volcanos.

Estimates of subvolcanic magma or pluton diameters range from 1 to 5 km for stratovolcanos (Table 1). Volume estimates

TABLE I

Depth and Size of Magma Chambers and Stocks

Volcano	Depth to top of Plutons (Km)	Diameter Dimensions (Km)	Volume Km^3	Reference
Strato Volcanos, Subvolcanic Plutons				
Central Andes	< 3	1.05 by 1.7	1.5	Francis, et al., 1983
New Guinea	2-4	0.5 to 2		Branch, 1976
Bolivia Volcanos	< 2	1 to 2	1-2	Grant, et al., 1980
Bolivia Volcanos	1-5			Siltstone, et al., 1975
Ruapehu, New Zealand	1.5-6	1 to 2	2-4	Latter, 1981
Spanish Peaks, Colorado		2.8 to 4.4	* 22	Johnson, 1968
Avachinski, Kamchatka	2.4-3	1.6 by 5	18	MacDonald, 1972
El Salvador,	1-2	1	1	Gustafson & Hunt, 1975
Shallow Magma Chambers				
Vesuvius	5.6			McDonald, 1972
Sakurajma, Japan	3 and 9.7			MacDonald, 1972
Saint Helens	7-9	1.5	*12	Scandone & Malone, 1985
Medicine Lake	6 - 12			Eichelberger, 1981
Medicine Lake	4-8		2-8	Heiken, 1978
Newberry, Ore. **	2-6		10-12	Williams & Finn, 1981

Calderas:

Klyucheuskaya, Kamchatka	48-64			MacDonald, 1972
Katmac; Alaska	10-38			MacDonald, 1972
Mauna Loa	15-30			Casadevall & Hazlett, 1983
Kilauea	2-5			Casadevall & Hazlett, 1983
Kilauea	3-4			MacDonald, 1972
Valles Caldera	4.7	* 9	* 30	Nielson & Hulen, 1984
Long Valley	4.5-5.5	*3 to 13	* 70	Sanders, 1984
Long Valley	3.7	2 by 6		Elbring & Rundle, 1985

* Number estimated in this study based on figure or data in reference.

** Newberry may be considered a caldera, but is grouped with the stratovolcanos here because of it's small size and Cascades location.

are more variable but a few km^3 appears typical. Note that the volumes of pluton or magma estimated for true calderas, Valles and Long Valley, are considerably larger than for stratovolcanos.

Western Cascade Stocks

The Western Cascades have been deeply eroded since the Miocene when intermediate volcanic rocks (Priest and Vogt, 1983) probably formed several stratovolcanos. Stocks exposed in the Western Cascades of Oregon may be related to this volcanism or earlier Oligocene rocks, and probably were subvolcanic magma chambers or intrusions emplaced under volcanos similar to the present High Cascade volcanos. A compilation of size and other data on central Western Cascade stocks is presented in Table II. The average range of stock dimensions, 1.6 by 2.8 km, is essentially the same as for plutons under Circum-Pacific stratovolcanos, 1.1 by 2.4 km (Table I). Volumes are harder to compare. An average exposed volume of 1.5 km^3 for eight Western Cascade stocks was estimated based on area and vertical exposure. Vertical exposure is a function of topographic relief in the area, probably does not relate to stock volume, and in each case is an order of magnitude less than horizontal dimensions. Shape or configuration of shallow intrusions will be discussed in the next section.

There is little data on the depth of emplacement of the Western Cascade stocks. Pollock and Cummings (1985) estimate a minimum depth of 800 m for formation of fluid inclusion in North

TABLE II

Western Cascade Stocks

Location	Dimensions* (km)	Area (km^2)	Number Phases	Rock Types	Fracture Spacing	Thermal Alteration
Detroit Dam	1.6 X 2.4	3.9	4	diorite granodio.	0.5-1 m	yes
Middle Santiam River	1 X 3.2	3.2	1	granite	0.5-2 m	minor
Nimrod	3.2 X 5.3	14.2	2	monzonite diorite	5 cm-1 m	yes
Cougar Dam **	0.85 X 2.7	2.3	1	dacite	0.5-1 m	minor
Lowell	1.6 X 2.3	4.7	1	rhyodacite	2-10 m	none?
Scott's Mtn.	-3.2 X 3.2	10.4	3	monzonite syenite	1 m	none?
North Santiam Dist.	0.8 X 2.2	1.7	1	diorite	?	yes
Castle Rock	0.55 X .85	0.47				
Averages	1.6 X 2.8	5.1				

* Size data from Peck, et al., 1964; Pollock and Cummings, 1985; and field reconnaissance by author.

** The Cougar Dam dacite is probably an intrusive dome.

Santiam district where a small stock is exposed. Fluid inclusion samples collected from a few stocks for the present study did not have usable primary inclusions and secondary inclusions were vapor-rich suggesting boiling and were not useful for depth estimation.

One exception is the Cougar Dam dacite intrusion. Inclusions in quartz crystals filling vugs in the dacite have a homogenization temperature of 162°C which indicates a boiling point depth of only 56 m. The quartz may significantly post-date intrusion. A very shallow depth of emplacement is compatible with the fine to vitric texture and large vugs in the dacite. The bounding faults on the east and west sides of the dacite (Priest and Woller, 1983) appear to have been produced by emplacement of the dacite, and the rock is chilled near these contacts. Therefore the Courgar Dam dacite appears to be an intrusive dome emplaced 100 m or so below the surface, not a subvolcanic stock. The dacite is listed in Table II because it provides an example of the size of magma intrusions in the region.

Three lines of evidence point toward most of the Western Cascade stocks forming from short lived subvolcanic intrusions rather than long lived shallow magma chambers. The first is emplacement in the related volcanic pile. Stratigraphic control in the Western Cascades is not defined enough to determine with certainty what thickness of rocks have been eroded from the

exposed stocks in Central Oregon. However, erosional relief suggests that over a kilometer of extrusive rocks has been removed from the canyon areas where stocks are exposed. Removal of much more than 2 km seems unlikely because of Pliocene basalts capping the ridges of late Miocene intermediate lavas (Priest and Vogt, 1983). Stratigraphic evidence suggests the Miocene Snoqualmie batholith was emplaced at a depth of 1.2 to 2.5 km (Erikson, 1969). This is comparable to the shallow end of the range of depths listed in Table I.

The second factor is limited contact alteration around stocks. Regional low-grade alteration not withstanding, alteration of country rocks hosting the stocks is generally minor in the Western Cascades. A long-term shallow magma chamber which fed a volcano should have had enough energy and time to considerably alter the country rock.

The third evidence for subvolcanic emplacement of stocks is the limited range of rock chemistry in most stocks. The composition of a magma chamber feeding a stratovolcano would be expected to change with time (Branch, 1976) because a variety of rock chemistries form a composite cone. Partial crystalization of the magma chamber between active pulses would leave evidence of different melt composition. The stocks on the Middle Santiam River, near Lowell, and in the North Santiam mining district have only one phase. The Nimrod stock has an early diorite phase which had cooled sufficiently to fail brittly when the main monzonite phase was intruded. Three or more phases are present

in the Detroit Dam and Scott's Mountain stocks (Table II) indicating these may have been longer lived magma chambers feeding strato cones.

SUBVOLCANIC CONFIGURATION OF INTRUSIONS AND STRUCTURES

What configuration of stocks, dikes, sills or magma chambers typically occur at or below the base of a volcano is an important question when interpreting geophysical data or evaluating the geothermal potential of a volcano. Further, when in the evolution of a volcanic edifice would these igneous bodies be emplaced, and what structures would control their location, shape and associated hydrothermal systems?

A coherent discussion of the subvolcanic configuration requires definition of a few terms. Igneous material emplaced within or near the base of the associated volcanic pile is here termed subvolcanic intrusions or stocks. Cascade stratovolcanos are about 1.5 to 2.5 km high, so subvolcanic intrusions are less than 3 km below the summit. Shallow magma chambers, if present, are deeper, possibly larger, and occur within the subjacent country rock; their tops are at depths of 4 to 9 km, and they extend to greater depth. Significantly deeper magma chambers are intermediate if within the crust, and magmas at or near the base of the crust or upper mantle are source areas or chambers. Although some continuum can be expected between the subvolcanic and shallow magma chambers, such a subdivision is agreeable with

the data presented in table I and will be useful in discussions of timing and location of associated thermal systems.

Depth of Intrusions

Subvolcanic intrusions have been investigated most intensely for associated mineralization. Where the depth of emplacement and associated volcanic activity could be determined, or reasonably inferred, the investigators are in close agreement. In the Central Andes (Francis et al., 1983), Bolivia (Grant et al., 1980), New Guinea (Branch, 1976), and El Salvador, Chile (Gustafson and Hunt, 1975) intrusions were emplaced at 1 to 3 km below the volcano summit and have dimensions of 2 km or less (Table I). This agrees with the depth and size estimates for Western Cascade stocks in this study. Current magma bodies this shallow, and in a subduction-related setting are reported only for the Ruapehu area, New Zealand (Latter, 1981), Arachinsky, Kamchatka (MacDonald, 1972), and possibly Newberry, Oregon (Williams and Finn, 1981, as cited by Priest, 1983). The sizes of the subvolcanic magma bodies are similar to the exposed stocks except for the magma chamber postulated for Newberry, which is a caldera. The magma chamber under Newberry may be below 10 km and/or solidified (Iyer, 1985).

Most current magma chambers reported, however, are deeper than 3 km and generally larger than exposed stocks (Table I). This suggests that the stocks exposed in the Western Cascades and those of New Guinea and the Andes were formed by subvolcanic

intrusions, whereas longer-lived shallow magma chambers occur at depths of 4 to 9 km (Table I). The scarcity of subvolcanic (1-3 km deep) magma at present would be expected because small 1-4 km^3 intrusions in near-surface rocks exposed to groundwater would cool relatively quickly and be short-lived as magma chambers compared to deeper and larger intrusives. Magma chambers with dimensions less than about 5 km are smaller than the resolution limit of the teleseismic technique (Iyer, 1985), a principal method for detecting these bodies. Also, the data are biased in favor of shallow chambers because erosion to plutons deeper than the volcano base removes direct evidence of the associated volcano, if any. An example of the subvolcanic and shallow magma chamber division of emplacement is provided by the Snoqualmie batholith in Washington. Stratigraphic evidence suggest that the eight-phase granodiorite pluton was emplaced at a depth of 1.2 to 2.5 km, but chemical petrology suggests the biotite in the pluton crystalized in a deeper magma chamber at a depth of 4 to 7 km (Erikson, 1969).

Subvolcanic stocks may not be emplaced until near the end of a volcano's active life. The principal force for the rise of magma is buoyancy (Yoder Jr., 1976). Therefore, a magma generated in the source region, lower crust or upper mantle, will tend to rise to the crustal level where magma density approximates rock density. As the magma differentiates and stratifies at shallow crustal depth, the more silicic and volatile rich fraction, which is less dense than the parent

magma, will move upward once viscosity of the magma and competency of confining rocks are overcome. Therefore, subvolcanic emplacement of stocks would be likely to occur late in development of a stratovolcano and may not have occurred yet in many active volcanos.

Subvolcanic Intrusion Shapes

The shape and abundance of subvolcanic intrusions, that is dikes, sills, and stocks, are important factors in developing a subvolcanic model. Dikes are present in most volcanic terrains but the relative sizes and abundance of dikes beneath volcanos can vary widely. In the Spanish Peaks region of Colorado, for example, hundreds of radial dikes up to 22 km long and 30 m thick extend out from granite and gronodiorite stocks (Johnson, 1968). The intrusions in the Spanish Peak region include small stocks and igneous breccia plugs, as well as small laccoliths a few km^2 in area and a few hundred meters thick (Johnson, 1968).

An extreme example of dike emplacement in a volcanic edifice is the Koolau dike complex, Oahu (Walker, G. P., 1986). In this complex, narrow, parallel dikes compose over 50 percent of the rock mass. The mid-plate, hot spot setting of Koolau is quite different from the Cascades. However, during earliest Pleistocene basaltic shield volcanism, east-west extension in the High Cascade graben (McBirney and White, 1982) would have been favorable for basaltic dike emplacement. The fissure zones on

the north and south flanks of Newberry volcano are also the surface expression of basalt dikes.

Sills are dominant in some volcanos, as in the Messum complex, South Africa, which consist of multiple gabbro sills and central subsidence forming a caldera (MacDonald, 1972). One of the laccoliths in the Black Hills, Colorado, is composed of a series of thick sills (Johnson, 1968). At Red Mountain, Arizona (Corn, 1975) a volcanic pile of pyroclastics, lava flows and sills rest on what was a laminated siltstone. The siltstone has been inflated by thick and extensive sills of andesite which have altered it to hornfels. Dikes and irregular monzonite intrusions were also emplaced in the 3 km thick complex so that now it is 80 per cent intrusions and only 20 percent hornfels (Corn, 1975).

The model of andesitic stratovolcanos developed by Branch (1976) suggests a balance and relationship between stocks, dikes and sills. In his model, based on New Guinea volcanos, magma rises along conduits from the mantle and accumulates in subvolcanic chambers from which it subsequently erupts. This process forms a single eruptive cycle which last a few months to a few years. Remnants of multiple evacuated magma chambers from several eruptive cycles form a complex of coalescing sills, dikes, pipes, and laccoliths in a zone 3 to 5 km across (Figure 1). When a large part of the magma in a cycle does not erupt before crystallization, a small stock 0.5 to 2 km across is formed (Branch, 1976).

FIGURE 1

This model appears to fit well with the High Cascade stratovolcanos. Subvolcanic magma chambers would be short-lived and therefore rare at any particular time. The subvolcanic magma chambers would be small, $\leq$ 2 km in diameter, would cool rapidly, and would be difficult to detect. This would not account for fractionation or differentiation of magma which would have to occur in deeper shallow or mid-crustal magma chambers. Stocks in the Central Western Cascades are generally close to equidimensional (Table II). Scott's Mountain, Nimrod and Detroit Dam stocks have several phases and therefore may represent multiple eruptive cycles. A few large unmapped radial dikes are present around Scott's Mountain and the Detroit Dam stocks. Short dikes radiate from the Peterson Butte stock near Lebanon, Oregon (Frank. 1974). Many dikes are reported in the Western Cascades (Peck et al., 1964), but most are not mapped so their relationship to possible eruptive centers is unknown. Some exposed plugs in the High Cascades are surrounded by radial dike swarms (Peck, et al., 1964), and radial dikes are present at Broken Top (Taylor, 1978). Sills and laccoliths have not been reported in the Cascades.

The model of a subvolcanic porphyry copper deposit presented by Francis et al. (1983) is based on Central Andes copper and tin deposits in more silicic volcanos. This model follows the more classical porphyry concept which assumes subvolcanic mineralizing stocks are finger-like extensions of a much larger shallow magma chamber (Figure 2). An excellent three dimensional study of the

FIGURE 2

El Salvador, Chile deposit presented by Gustafson and Hunt (1975) exemplifies this volcano model. This model is for a more acidic, granodioritic to rhyolitic, low-profile volcano as compared to the diorite-andesite stratovolcano of Branch's model. Although Quaternary Cascades volcanism is dominantly basaltic to andesitic, dacite-rhyolite is a significant component (White and McBirney, 1978). The porphyry stock model (Francis et al., 1983) is directed more to the caldera or silicic dome setting which may be applicable to Newberry, Medicine Lake and several dacite to rhyolite domes and flows in the Cascades.

The contrast in stocks between these two models (Figure 1 and Figure 2), stocks which are rootless intrusions or extensions of a shallow magma chamber, points to the question of a stock's downward continuance. Peck et al. (1964) characterize Western Cascades stocks as having nearly vertical margins. The Cougar Dam dacite has a flat base exposed (Priest and Woller, 1983) but, as discussed above, is probably an intrusive dome. Some of the stocks at El Salvador, Chile, flare outward with depth (Gustafson and Hunt, 1975). The Cerro Rico, Bolivia, stock tapers downward to a dike 100 m wide (Francis et al., 1983). Many examples of variation in stock shape with depth could be provided from deep mines in the Western United States but most do not extend deep enough for a definitive answer.

Hydrothermal Breccia

Hydrothermal breccias are common in mineralized subvolcanic rocks, and their formation seems to be directly related to hydrothermal systems as well as providing channel ways for thermal fluids (Sillitoe, 1985). Grant et al. (1980) list breccia pipes as one of three general characteristics of igneous rocks associated with mineralization. Grant states that hydrothermal breccia pipes are prominent and have several phases of brecciation. Hulen and Nielson (1985) report multiple-stage hydrothermal breccia formation and alteration at the margin of the Valles caldera, New Mexico, for example. Hydrothermal and intrusive breccia pipes and dikes associated with stocks and mineralization are reported by Sillitoe et al. (1975) Bolivia, Gustafson and Hunt (1975) Chile, Corn, (1975) Red Mountain, Arizona, Bonham Jr. and Giles (1983), Western U.S.,and many other examples could be cited. The association of breccia pipes with hydrothermal systems is well established (Bryner, L., 1961; Perry, V.D., 1961; Sillitoe, 1985). Studies have demonstrated the process that forms hydrothermal breccias involves high energy movement of hot fluids (Reynolds, 1954) down a steep pressure gradient during a short time interval (Wolfe, 1980; Burnham, 1985). The fluid pressure may result from sudden heating of ground water by an intrusion (Wolfe, 1980) and be termed a phreatomagmatic explosion; from slow pressure build up due to exsolved magmatic fluids (Norton and Cathles, 1973) which escape explosively forming breccia pipes, or resurgent boiling in the

upper part of a pluton, may produce the overpressed system (Burnham, 1979). Also pressure buildup may result from conductive heating of connate or meteoric water confined by a self-sealed zone or aquiclude (Nelson and Giles, 1985) also termed phreatomagmatic. Formation of breccias in volcanic arcs has been reviewed by Sillitoe (1985). Mineralized hydrothermal breccias are associated with a maar volcano and domes at Wau, Papua New Guinea (Wolfe, 1980; Sillitoe et al., 1984).

Hydrothermal breccias are important as indicators of paleo-hydrothermal systems and as possible channelways in existing systems. Hydrothermal breccias are associated with porphyry plugs in the cloudy pass batholith in the Glacier Peak area, Washington (Tabor and Crowder, 1969), and mineralized breccia pipes are present in the North Santiam mining district near a diorite stock (Pollock and Cummings, 1985). Minor pyrite occurs near the top of Duffy Butte which has vent breccia (Davie, 1980).

Francis et al. (1983) suggest that phreatic eruptions are the surface expression of hydrothermal breccia formation. Tabor and Crowder (1969) state that some breccia pipes vent as diatremes, and Sillitoe (1985) equates phreatomagmatic breccias with diatremes. Many breccia pipes and dikes do not reach the surface (Gustafson and Hunt, 1975; Bashkirov, 1983) or they may vent into the main volcanic vent leaving no surface indication of their presence.

Shallow and Mid-Level Magma Chambers

Data on the shape and size of shallow (4-9 km deep) and mid-level magma chambers are sparse due to limited resolution capabilities of detection methods. However, a brief review is of value because the shallow magma chambers may support hydrothermal systems. Paleo-magma chambers exposed as plutons display almost every shape in plan view, but are typically irregular and close to equant. All evidence of what type of volcanic feature(s) was associated with these plutons has been removed and therefore, exposed plutons will not be discussed extensively in this model.

The volcano model presented by Branch (1976) suggests that magma chambers below 4 km are small (1-2 km dia.), irregular stocks. The more typical model for porphyry mineralization is a rounded magma body several km broad (Francis et al., 1983). It should be noted, however, that the objective of both these models is the resulting mineralization, not to define magma chamber configuration. In general, shallow and mid-level magma chambers are emplaced and fed by buoyant rise of a viscous material through the plastic or quasi-plastic lower crust (Yoder Jr., 1976). Therefore, their mechanism of emplacement and shape may be similar to salt diapirs which are emplaced by plastic deformation (Jackson and Talbot, 1986). Mahmood (1985) interprets the Zaer pluton, Morocco, as emplaced by a "polyphase diapiric process". The polyphase Mineral Mountains pluton, Utah, was emplaced during continued diapiric rise (Nielson et al., 1986). The diapiric emplacement model does not tightly define

the shape (Jackson and Talbot, 1986) due to the effects of structures and inhomogeneities in the country rocks. The model would suggest that high-viscosity magma would typically have a thick stem or feeder conduit below the main mass. However, S-Wave attenuation in the Ruapehu, New Zealand area suggests irregular, equant to dike-like bodies without detectable feeder conduits (Latter, 1981).

MacDonald (1972) describes magma chambers 10 km to 38 km deep under Katmai, Alaska, as vertically flattened spheroids. The magma chamber 5 to 13 km under Long Valley, California (Sanders, 1984) is ellipsoidal with two cupolas extending above the main chamber, or if the two cupolas are not connected at depth, one is ellipsoidal and the other triangular. Shallow or subvolcanic basaltic magma chambers in Iceland have been envisioned as lenticular, formed by multiple feeder dikes inflating a large sill (Gudmundson, 1986). The model of batholith emplacement presented by Whitney and Stormer Jr., (1986) envisions a deep, lenticular chamber at about 25 km depth and a shallow chamber at about 5 km depth forming by collapse of country rock into the deep chamber.

Below Mount St. Helens in the Northern Cascades, seismic data appear to define a cylindrical magma body, 1.5 km in diameter, extending from a depth of 7 km to at least 13 km (Scandone and Malone, 1983). Several magma chamber shapes have been assumed for Newberry Crater to fit heat flow and gravity

data (Blackwell an Steeles, 1983), but the shape is not constrained by these data.

Some shallow magma chambers are not located directly under the associated volcanic vents. The postulated magma chambers 4 to 7 km below Ruapehu and Ngauruhoe volcanos, New Zealand, are offset as much as 4 km laterally from the surface vent, suggesting the chamber to vent conduit is 30 degrees from vertical (Latter, 1981). The magma chamber 9.7 km below Sakurajima volcano, Japan is about 2 km or 11 degrees northeast of the volcano (MacDonald, 1972). These two examples suggest the significance of structural control on magma chamber to surface conduits.

Subvolcanic Structures

As illustrated by the Sakurajma and Ruapehu volcanos, subvolcanic structures can affect the location of vents and therefore thermal systems relative to the magma chamber. Subvolcanic structures will be divided into two groups for this discussion, local structures produced by the magma and regional or pre-existing structures.

Stress distribution determined by study of three-dimensional theory of elasticity around a spheroidal magma chamber (Koide and Bhattacharji, 1975) predict a concentric distribution of zones of dominantly concentric fractures, in the central area, and radial fractures farther out, above a vertically elongate prolate magma exerting increasing pressure (Fig. 3). The wedging action of the

intruding magma places a radial compressive force on the rock producing radial fractures next to the magma chamber and wide domal uplift above. The radial compression around the magma and wide domal uplift results in an area of horizontal extension, concentric fractures and relative subsidence directly above the magma chamber (Figure 3 A). The concentric fractures form funnel-shaped normal faults with computed dips of 45° to 60° (Koide and Bhattacharji, 1975). The model predicts a system of radial and concentric fractures and is in good agreement with the structure of Silverton Cauldron, San Juan Mountains, Colorado, and could fit with Medicine Lake and Newberry Crater. Radial dike systems, such as at Spanish Peaks, Colorado, (Johson, 1968), and Three Fingers Jack, Oregon (Davie, 1980), may result from radial compressive forces. However, except for Crater Lake, central subsidence is not typical of stratovolcanos.

Burnham (1979) predicts a steeply-fractured central zone above a shallow, 6 km-deep, magma chamber. Intense shattering of rocks by inflation - deflation of subvolcanic magma chambers (Branch, 1976) could produce fracture permeability under a volcano.

Johnson (1970) presented a structural model for doming of a horizontal plate above a domed intrusion. This model suggests that above a neutral plane at about the center thickness of the plate, the rocks are in tension above the middle of the intrusion, producing open fractures. Below the neutral plane the plate is in compression preventing open fractures over the center

FIGURE 3

of the intrusion. Near the margins of the doming the reverse would be the case because the overlying plate is bent concave upward. Therefore, tension, producing open fractures, and dike emplacement increase toward the intrusion in the lower half of the plate along the margins of the dome. This model may have application in domed areas such as Medicine Lake and Newberry volcanos. However, significant structural doming is not reported for stratovolcanos.

Detailed structural data from the Cascades is sparse due to limited depth of erosion in the High Cascades and lack of detailed mapping around stocks in the Western Cascades. However, a few general observations were made during a reconnaissance study of Western Cascade stocks. Cooling joints occur at spacings of a few cm to a meter in all of the stocks (Table II). The joints appear open to fluid flow with only minor staining or alteration along them; water was seeping from joints in several exposures. Priest and Vogt (1982) thought that fractured intrusive rocks were more permeable than the altered volcanics they intrude. This may be true for the pyroclastic rocks, but the lava flow rocks, which are abundant, have retained significant permeability.

Dikes in the Western Cascades mining districts were generally unaltered, suggesting they did not serve as channel-ways for hydrothermal fluids. Dikes are often emplaced along faults or joints sets, and indicate structural trends. Dikes may also serve as permeability barriers to lateral flow in aquifers.

Regional or pre-existing structures are often the controlling factor for loci of volcanic vents, intrusions or hydrothermal channelways. The regional structures affecting the High Cascades have been reviewed by Kienle and others, (1981) and Priest and Vogt (1983). These structures will not be reviewed in this paper other than to note that the stratovolcanos occur in a graben and extensional faults are present. All faults examined in the Western Cascades were clay filled but appeared to have fracture permeability along the plane of the fault in breccias or joints in the fault margins. The faults in the Western Cascades are barriers to groundwater flow across the fault but may provide channelways for flow along a fault (U.S. Army Corps of Engineers, 1964).

Another important part of regional structure is the stratigraphy under a stratovolcano. The types and alteration or metamorphic condition of the underlying country rocks will have a significant effect on heat flow and possible reservoir rocks. The base of the low-gradient rain curtain at Newberry Volcano is controlled by semectite-altered pyroclastic beds (Wright and Nielson, 1986). Stratigraphy may control the formation and depth of the magma chamber. Guomunosson (1986) suggest the formation of subvolcanic magma chambers (about 1.5 km depth) in Iceland is controlled by layers of different elastic moduli which form stress barriers. Where basaltic lava flows and pyroclastic beds are subjected to lateral compression, the basalt carries more of the stress because of its high elastic moduli compared to the

pyroclastic layers. Similar rock types are present under the High Cascades.

SUBVOLCANIC THERMAL SYSTEMS

This section will attempt to characterize a subvolcanic thermal system's depth, associated alteration, structural controls and temperature. Because of the rather broad topics and limited applicable data, the discussion is brief. The topics of chemistry, alteration petrology and geothermometry have been addressed by many studies and will not be discussed here.

Depth of Thermal Systems

The expected depth of a thermal system is an important factor for exploration program design and cost of development for a potential resource. Reported or estimated depths of thermal systems or the mineralization formed by a hydrothermal system are listed in table III. The limited list of primarily stratovolcano occurrences suggests that a depth of 1 to 2 km is the typical depth for a thermal system. Minimum boiling point depths for fluid inclusions from the Quartzville, North Santiam and Bohemia mining districts in the Western Cascades (Table IV) indicate that these hydrothermal systems formed below 0.7 to 1 km depth. These depths are compatible with published depths, (Table III) and essentially the same as for the current thermal systems under Mount Hood (Wallenberg, et al., 1979), Mount Lassen (Muffler, et al., 1982) and Newberry Volcano (Sammel, 1981). Power's (1986)

study of fluid inclusions in vein quartz concluded that depth of cover during mineralization in the Western Cascades was 0.74 to 1.8 km. These shallow depths are generally to the top of systems which may extend to considerably greater depth. The data may be biased toward shallow systems by the limited erosion and lack of drilling data in the Cascades. Much deeper systems which are masked by a "rain curtain" of cold ground water or capped by a deep aquitard are possible, and given the right structures, thermal systems as deep as the heat source may exist.

Thermal System Occurrence Relative to the Heat Source

Comparison of depths of thermal systems (Table III) and depths of subvolcanic plutons (Table I) suggest that thermal systems occur 0.5 to 3 km above the associated heat source. Most of the stocks in the Western Cascades are exposed in the deep canyons and the mining districts of paleo-thermal systems are near the mountain tops. Mining districts average 460 m higher in elevation than the exposed stocks. Stratigraphic control in the area is not detailed enough for a better comparison, and fluid inclusions useable for determination of depth of emplacement were not obtained from the stocks.

Existing volcano models (Branch, 1976; Burnham, 1979), show the hydrothermal system as occurring directly above the heat source in the volcanic vent. This would appear to be the case for the three known high temperature system in the Cascades: Newberry, Mt. Hood and Mt. Lassen. Subvolcanic structures

TABLE III

Minimum Depth and Temperature of Thermal Systems

Location	Depth of Systems (km)	Temp. °C	Metals	Type Volcano	Reference
Bolivia	.8-2		Sn, Ag	Strato	Sillitoe, et al., 1975
Bolivia	1-2		Cu	Strato	Francis, et al., 1983
El Salvador Chile	2	< 350 & 360-600	Cu	Strato	Gustafson & Hunt, 1975
New Guinea	1-4		Cu	Strato	Branch, 1976
North Santiam	$\geq$ .8	218-310	Cu, Zn, Pb	Strato?	Pollock & Cummings, 1985
*Mt. Lassen	$\leq$ 1	230-240		Strato	Muffler, et al., 1982
*Mt. Hood	1	104-170		Strato	Wollenberg, et al., 1979
Newberry	.9	265		Caldera	Sammel, 1981
Valles Caldera	.6-2.4	200-310 Mo		Caldera	Hulen & Nielson, 1986
Western U.S.	< 2	150-300	Au, Ag		Ponham, Jr., & Giles, 1983
Average	1.1-1.8	216-311			

* Actual depth not stated in reference, but indicated by schetch figures and general discussion.

discussed above and alteration to be discussed next suggest that some thermal systems occur in rocks to the side of intrusions or in the fractured and cooling stock itself. Zoned alteration halos produced by thermal systems extending from the stock into country are shown by Francis, et al., (1983) as part of his model reproduced here as Figure 2.

Some magma chambers are not located directly under the associated volcano, the Ruapehu, New Zealand area for example (Latter, 1981). Therefore a thermal system may be laterally removed from the heat source due to structural control and not be located directly under the volcano.

Alteration

Alteration associated with subvolcanic thermal systems is minalogically similar to that of metallic mineral deposits, althought often not as intense, and valuable minerals may not be present. Pollock and Cummings (1985) report potassic and phyllic alteration in the North Santiam district. The chlorite-smectite, quartz and pyrite alteration in the Newberry 2 drill cone (Bargar and Keith, 1984) is less intense and mostly restricted to fractures.

Significant alteration is evident around about half the stocks in the Western Cascades (Table II). The extent of altered rock and contact metamorphic effects was generally limited around these stocks. At the Detroit Dam stock, for example, moderate to strong argillic alteration extends only 300 feet into the country

rock and 100 feet into the stock on the northeast side. The southeast part of the stock, where several igneous phases are present, has more pervasive alteration extending several thousand feet across both the stock and country rocks. The most likely place for significant alteration to occur is directly above the stock where erosion has removed the evidence. Generally, the stocks themselves are little altered, except for the south part of the Detroit Dam stock.

Structural and Lithologic Controls

The most likely structures controlling a subvolcanic thermal system would be the magma-induced structures discussed above. For a convection model, meteoric water enters the system through the radial fractures around and above the pluton, and thermal fluids rise directly up the vent, up the funnel-shaped normal faults (Koide and Bhattacharji, 1975) or the stockworks above (Burnham, 1979). Breccia dikes or pipes also provide important channelways for hydrothermal systems (Francis, et al., 1983; Burnham, 1985).

At Newberry Volcano, the thermal system seems to be restricted to the central caldera and its ring-faults, and is not present at comparable depths under the volcano's south flank (Wright and Nielson, 1986).

The thermal systems at Mount Hood (Wollenberg, et al., 1979) and Mount Lassen (Muffler, et al., 1982) are recharged at high elevation above the vent area and the thermal fluids flow away

from the heat source toward the volcano's flank. For these systems, volcanic beds and structures within the stratovolcano control the movement of thermal fluids. Clay-altered pyroclasticbeds, such as at Newberry volcano (Wright and Nielson, 1986), can form an effective boundary between a thermal system and overlying cool meteoric water. At Newberry Volcano, low-temperature clay alteration in pyroclastic beds has low resistivity which accounts for a resistivity anomaly detected by surface methods (Wright and Nielson, 1986).

Regional structures and stratigraphy may have a major effect on the location, depth and size of the thermal system. These factors will depend on the volcano or location in question.

Temperatures

Temperatures of formation for Western Cascade hydrothermal systems were 244 to 310° C based on fluid inclusion data for this study, (Table IV). A range of 167 to 319°C was determined from fluid inclusions by Power (1986). Reported temperatures for thermal systems associated with stratovolcanos are in the same range (Table III), except for the lower temperature of the Mount Hood system which Wollenberg, et al., (1979) believe to be diluted. Calculated reservoir temperatures for waters from Breitenbush and Belknap Hot Springs are below 200° C (Priest & Vogt, 1983).

TABLE IV

Western Cascades Fluid Inclusion Data

Mineral Districts Sample #	T° Homogenization (°C)	Min. Boiling Depth (m)	Freeze Temp (°C)	Salinity Wt. %	Mineral
Quartzville,OR S-85-6	280	759	-1.4	2.4	qtz
Quartzville-OR-S-85-11	244		0.0	fresh	qtz
North Santiam OR-S-85-5	279	720	-3.4	5.5	sphal
North Santiam OR-S-85-5	295	1,000	- .3	0.2	qtz
North Satiam *	245-310	≥800		< 2	qtz
Bohemia Mine OR-R-85-2	284	810	-1.7	3.1	qtz
Averages	277	800		2.2	
Cougar Dam Intr. OR-C-85-2 (Intrusive dome)	162	56	-.65	1.0	qtz

* Pollock and Cummings, 1985

All other fluid inclusion data by Joe Moore, UURI.

STRATOVOLCANO-GEOTHERMAL SYSTEM MODEL

A model for the subvolcanic structure and geothermal system(s) of a Cascades type stratovolcano has been formulated based of the foregoing data and discussion. The main associated magma chamber from which eruptions originate is 4 to 9 km deep and 4 to 12 km^3 in volume (Fig. 4). Fractionation would occur in this shallow magma chamber, and it would be resupplied periodically from a deep source. The resulting pluton would have multible phases and may be several times larger than the magma chamber was at any one time. Some volcanos may not have a shallow magma chamber, and their eruptions may originate directly from the sub-crust source.

Subvolcanic magma chambers, 1 to 3 km deep and 2 km or less in diameter, form only occasionally. Because of the subvolcanic magma chamber's small size, and the relatively cool, permeable country rock, the magma chamber is short lived compared to the duration of activity of the superjacent stratocone. An eruption may or may not occur during emplacement of a subvolcanic intrusion.

A magma body will tend to rise to, or accumulate at the depth of country rocks of equal density. Pre-exsisting structures may have considerable affect on the depth and shape of subvolcanic intrusions.

Magma produced fractures which could produce permeability near the intrusion would be near-vertical radial-compression fractures around the magma, and 45 to 65^o dipping extensional

FIGURE 4

faults in a funnel shape above the center point of the magma. This idealized fracture development may not be significant above small, subvolcanic plutons where pre-exsisting structural fabric and lithologic inhomogeneity dominate.

Dike complexes and multiple sills are significant structures in some volcanic areas, but are not present in the Western Cascades. However, east-west extension and graben formation are structural components in the High Cascades which are not present in the Western Cascades. Therefore, dikes may be significant in the High Cascades. The strong contrast of shield basalt flows over pyroclastic beds of the Western Cascade volcanic rocks may favor formation of sills in the High Cascades.

A geothermal system requires more than a heat source. Sufficient permeability and reservoir capacity must be present for the thermal fluid to gather and store the conductive evergy output from the heat source, while a partial "cap" or aquitard, natural or self-formed, prevents the thermal reservoir from being overwhelmed and swept away by too much cold meteoric water. The basaltic to andesitic lava flows and flow breccias in the High Cascades have very high permeability. Widespread, clay-altered tuff beds, such as under Newberry Volcano (Wright and Nielson, 1986) are the likely boundary between cool meteoric groundwater and deep thermal systems (Figure 4).

Thermal systems associated with subvolcanic stocks or vent plugs will probably be relatively small, short-lived, and located within or under the cone. The thermal systems at Mount Hood and

Lassen are examples. Thermal systems associated with 4 to 9 km-deep magma chambers or plutons could be larger and probably longer lived, therefore more likely to be present. Such a deep-source thermal system would be associated with eruptive activity, but may not be directly under the vent or a stratocone. The thermal system may rise to shallow depth if the right structures are present, or economic temperatures may occur only at considerable depth due to barriers to vertical flow and abundant cool groundwater. Reservoir permeability and deep levels may be a problem.

CONCLUSIONS

A subvolcanic geothermal reservoir is likely to occur within the stratocone or directly under it within 2 km of the surface. A reservoir in Western Cascades rocks will be in lava flows bounded by pyroclastic beds and faults or in cooling joints within the crystallized stock heat source. Hydrothermal breccia would form a rather small reservoir but could connect to extensive fracture systems. Reservoir volume is likely to be only a few km^3. A subvolcanic thermal system may be short-lived compared to the duration of volcanic activity of the stratocone.

Thermal systems associated with shallow plutons/magma (4 to 9 km deep) will be larger and possibly more abundant due to longer duration, but less likely to have a surface manifestation than the smaller systems associated with subvolcanic stocks. The

geothermal reservoir is likely to occur in a fracture system produced by regional structures and the magmatic heat source.

Faults are the most likely structures to provide channelways for hydrothermal fluids. Hydrothermal breccia pipes and dikes could be even more productive but harder to locate and drill into.

Geothermal systems and their heat sources in the Cascades may be difficult to detect by some geophysical methods. Existing magma chambers are probably too small to detect by seismic methods (Iyer, 1985). Low resistivity clay-altered pyroclastic beds one km or more deep will tend to mask the low resistivity of thermal systems (Wright and Nielson, 1986). The density contrast between country rock and intrusions may be low because depth of emplacement is partially controlled by buoyancy (Yoder, Jr., 1976). Pluton density will increase due to thermal contraction during crystalization. Therefore, the more cooled plutons less likely to still have a thermal system -- will have more of a gravity signature.

The data presented suggest the geothermal systems would occur within a few km of the associated stratocone or shallow intrusion. Careful exploration technique and well placed exploration holes will be required for discovery of Cascades stratovolcano geothermal systems.

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FIGURE CAPTIONS

Figure 1. Simplified cross-section through a nearly extinct andesitic stratovolcano. (from Branch, 1976).

Figure 2. Model for the volcanic superstructure of porphyry copper deposits. The essential surface expression is intermediate to acid dome exhibiting evidence of phreatic eruptions (from Francis, et al.,, 1983).

Figure 3A. Vertical section through an elongate magma chamber showing concentric and radial fracture pattern due to increase of magma and fluid pressure. (from Koide and Bhattacharji, 1975).

Figure 3B. Diagrammatic sketch of the horizontal zonal distribution of fractures above a vertically elongated prolate magma chamber. (from Koide and Bhattacharji, 1975).

Figure 4. Subvolcanic structural and geothermal composite model. Any one stratovolcano may have only a few or none of the structural-thermal components featured.

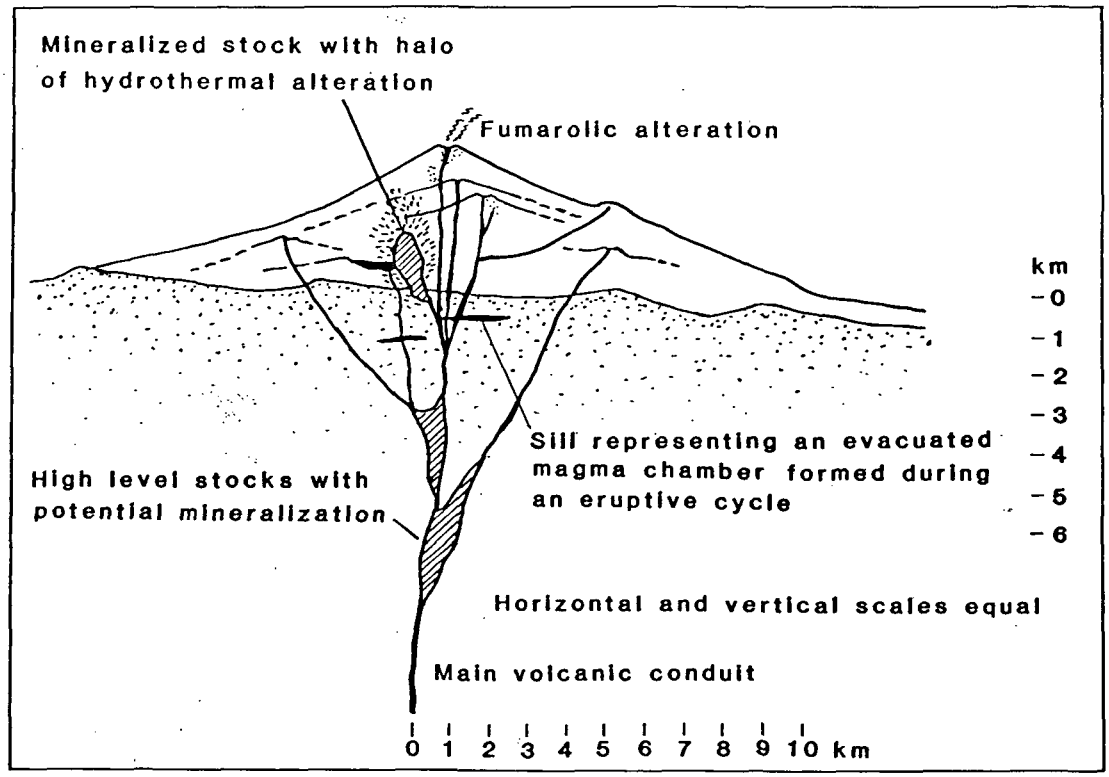

Mineralized stock with halo
of hydrothermal alteration
Fumarolic alteration
km
-0
-1
-2
-3
-4
-5
-6
Sill representing an evacuated
magma chamber formed during
an eruptive cycle
High level stocks with
potential mineralization
Horizontal and vertical scales equal
Main volcanic conduit
0 1 2 3 4 5 6 7 8 9 10 km

Fig. 1

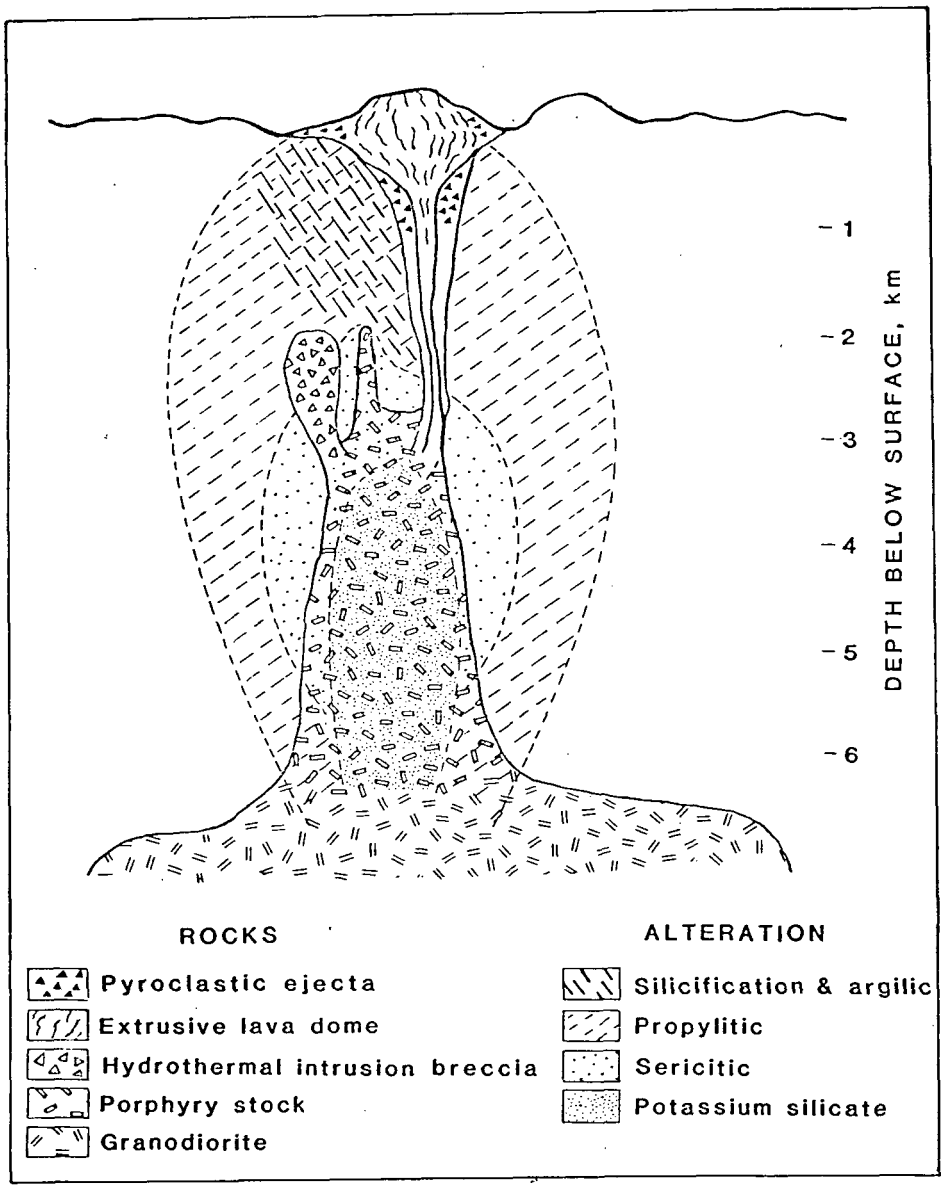

DEPTH BELOW SURFACE, km
1
2
3
4
5
6
ROCKS
Pyroclastic ejecta
Extrusive lava dome
Hydrothermal intrusion breccia
Porphyry stock
Granodiorite
ALTERATION
Silicification & argilic
Propylitic
Sericitic
Potassium silicate

Fig. 2

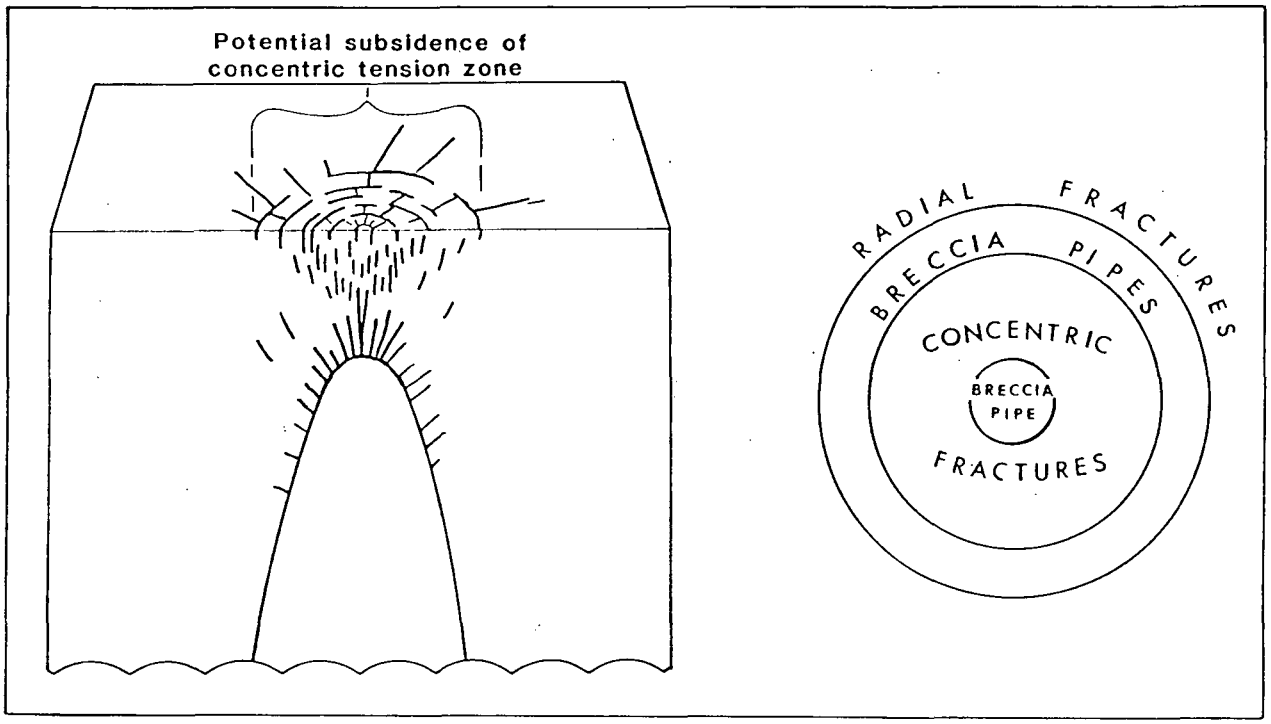
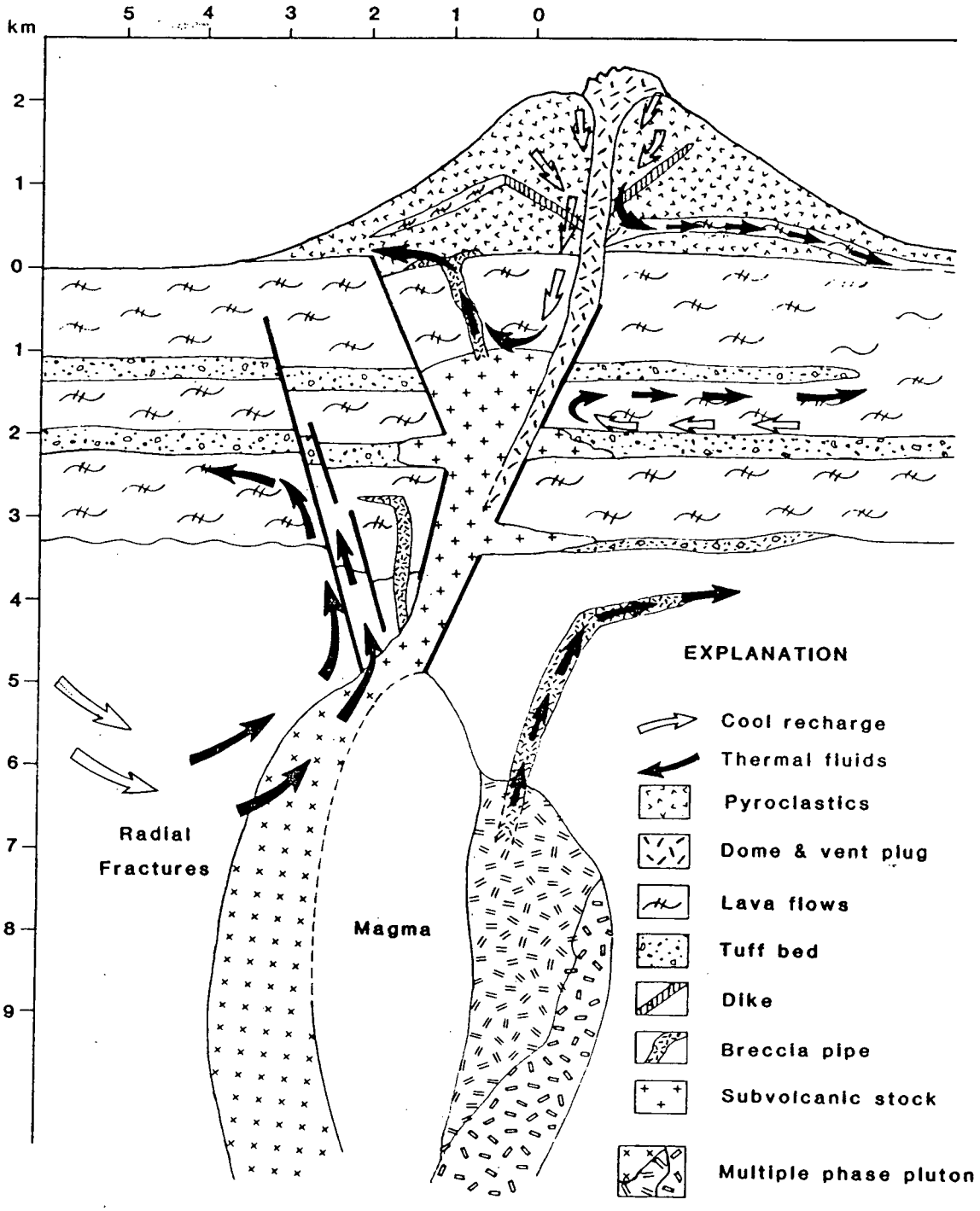

Potential subsidence of concentric tension zone
RADIAL FRACTURES
BRECCIA PIPES
CONCENTRIC FRACTURES
BRECCIA PIPE

Fig 3


km
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4
3
2
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2
1
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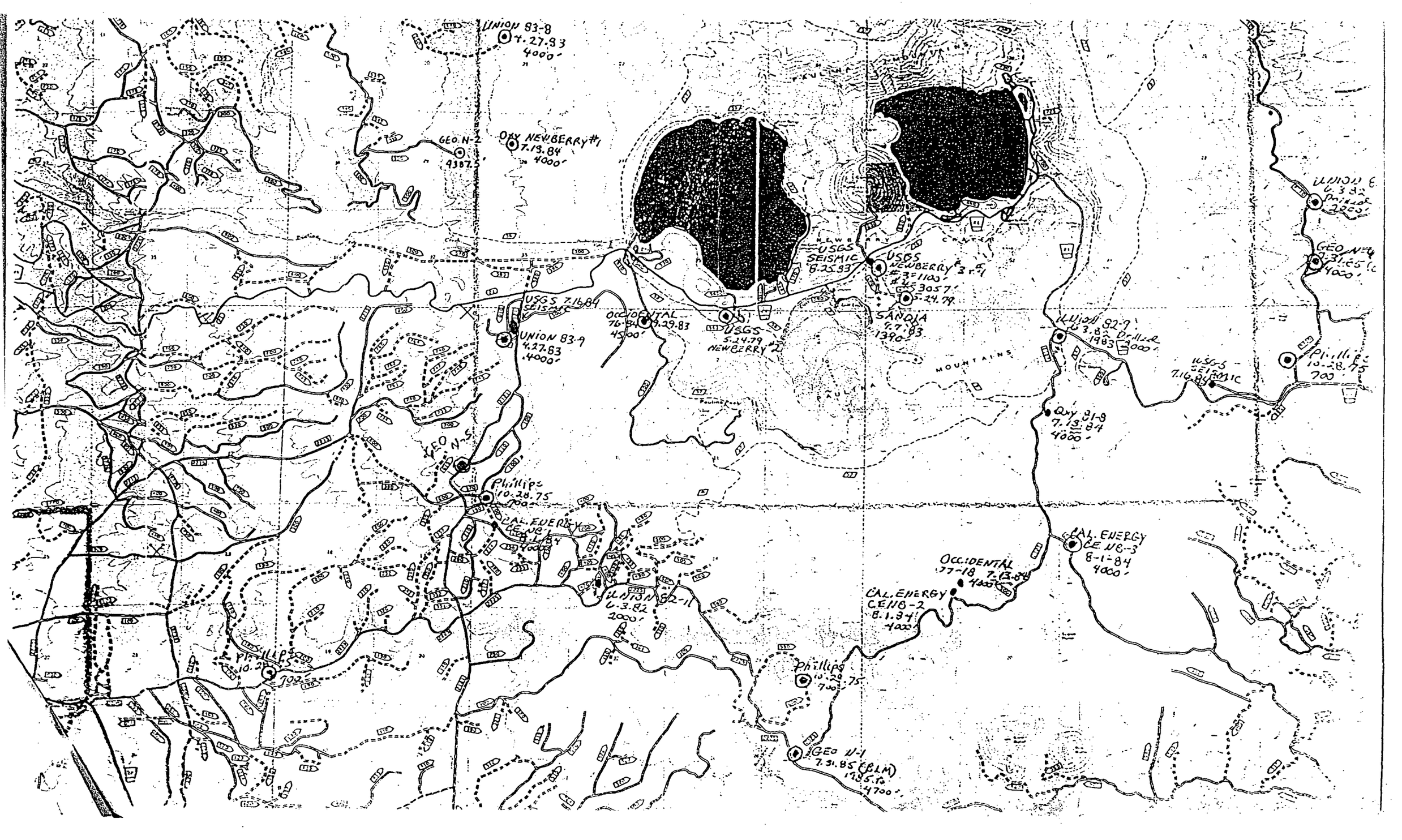
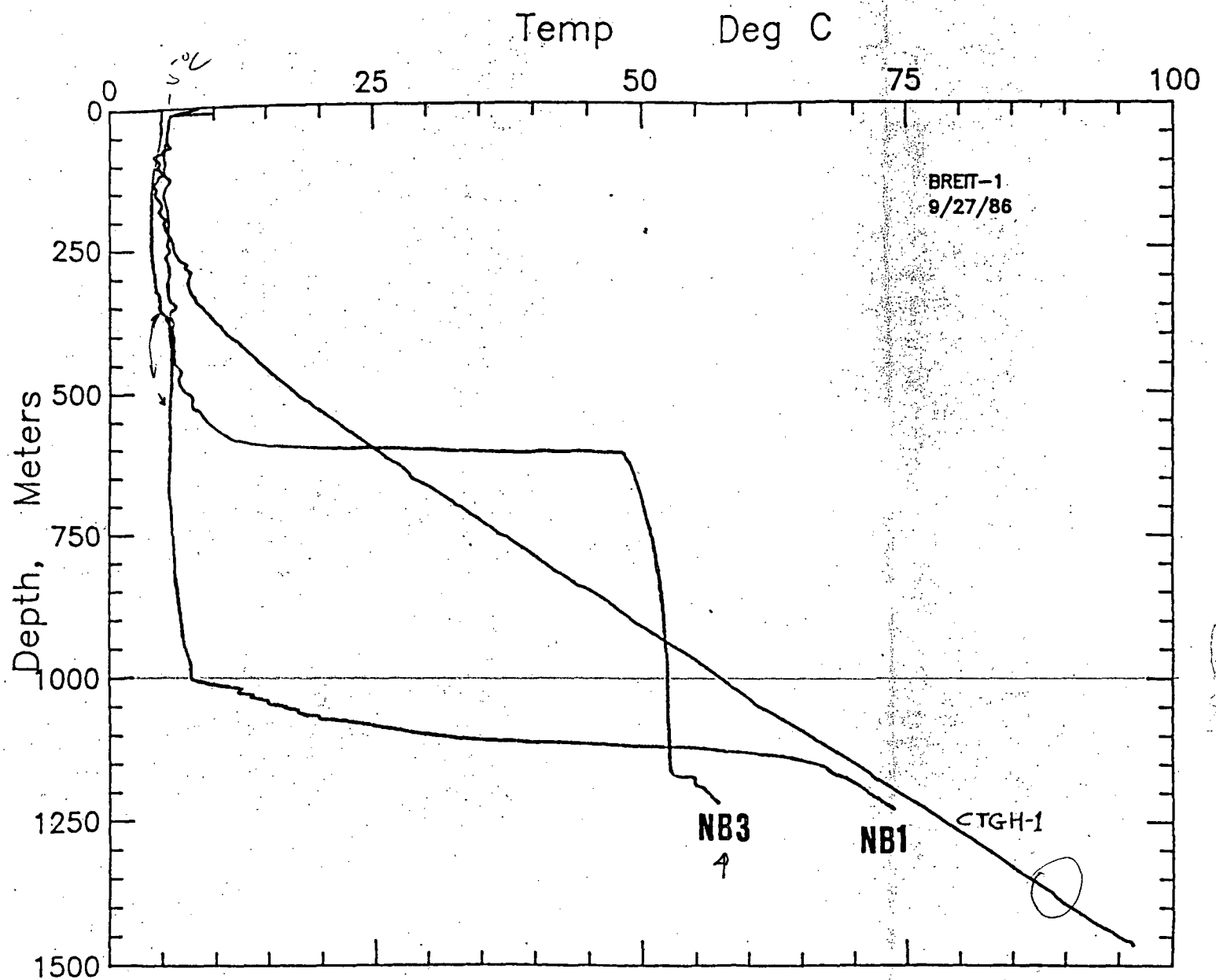
1
2
3
4
5
6
7
8
9
Radial
Fractures
Magma
EXPLANATION
Cool recharge
Thermal fluids
Pyroclastics
Dome & vent plug
Lava flows
Tuff bed
Dike
Breccia pipe
Subvolcanic stock
Multiple phase pluton


UNION 83-8
T. 27. 83
4000'
GEO N-2
4387.5'
ORX NEWBERRY #1
7.13.84
4000'
USGS
SEISMIC
8.25.83
USGS
NEWBERRY #3
3057'
5.24.79
SANQUA
7.7.83
1390'
USGS 7.16.84
SEISMIC
OCCIDENTAL
76-8
9.29.83
4500'
USGS
5.14.79
NEWBERRY #2
UNION 83-9
4.27.83
4000'
MOUNTAINS
UNION 82-9
6.3.82
Drilled
1983
3000'
USGS
SEISMIC
7.16.84
Phillips
10-8.75
700
ORX 31-8
7.13.84
4000'
GEO N-5
Phillips
10.28.75
700'
CAL. ENERGY
CE VB-3
8-1-84
4000'
OCCIDENTAL
77-18
7.13.84
4000'
CAL. ENERGY
CENB-2
8.1.84
4000'
UNION 82-11
6.3.82
2000'
Phillips
10.28.75
700'
GEO N-1
7.31.85 (BLM)
4700'


Temp Deg C
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25
50
75
100
-1°C
0
250
500
750
1000
1250
1500
Depth, Meters
BREIT-1
9/27/86
NB3
NB1
CTGH-1

FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

FORM APPROVED
OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-86ID12623	Geothermal Map of the United States	7-1-86 through 9-30-86

Name and Address	5. Program/Project Start Date	6. Completion Date
David D. Blackwell Department of Geological Sciences, Southern Methodist University Dallas, Texas 75275	11/1/85	9/30/87

7. Approach Changes

☐ None

8. Performance Variances, Accomplishments, or Problems

During the fourth quarter of the project work continued on the U.S. Geothermal map data base and field work was initiated for the Cascade Range cost shared part of the project. The map data base project is approaching completion although contributions from collaborators are lagging. Contributions from Marshall Reiter (Southwest), Ed Decker (Northeast and East) Doug Smith (Southeast), Will Gosnold (Midcontinent), Paul Morgan (Midwest), and Jim Witcher (Arizona and New Mexico) are expected, but not in hand.

During September 1986, temperature logs were made in several Cascade holes. Included were the Thermal Power CTHG-1 hole, and GeoOperator holes N-1 and N-3. A copy of the temperature-depth plots is included. The quality of the GeoOperators hole curves are poor due to intra-hole water flow induced by connecting confined aquifers (artesian in the case of N-3, and subhydrostatic in the case of N-1). To avoid this problem the holes should have been grouted. Gradients in all the holes are equal to or greater than the expected high regional values and so the results are encouraging. The temperature-depth logs for the CTHG-1 and N-3 wells are not at complete thermal equilibrium and so these holes, as well as the Cal-Energy hole currently drilling at Crater Lake, will need to be logged during the summer 1987.

☐ None Samples were collected at the UURI core facility in Salt Lake City for thermal conductivity analysis. At the time of this report the preparation of the samples has begun.

Open Items

☐ None

tatus Assessment and Forecast

he Cascade Study is on track. The map completions is behind schedule, but should be ack on track by 12/15/86.

(7-81)

NOTICE OF FINANCIAL ASSISTANCE AWARD

(See Instructions on Reverse)

Susan Prestwich

Under the authority of Public Law 93-410 and

Subject to legislation, regulations and policies applicable to *(cite legislative program title)*:
Geothermal Research, Development and Demonstration Act Of 1977

1. PROJECT TITLE
Cascade Geothermal Drilling

2. INSTRUMENT TYPE
☐ GRANT ☒ COOPERATIVE AGREEMENT

3. RECIPIENT *(Name, address, zip code, area code and telephone no.)*
GEO Operator Corporation
545 Middlefield Road, Suite 200
Menlo Park, CA 94025

4. INSTRUMENT NO.
DE-FC07-85ID12613

5. AMENDMENT NO.
--

6. BUDGET PERIOD
FROM 9/30/85 THRU: 10/31/87

7. PROJECT PERIOD
FROM 9/30/85 THRU: 10/31/87

8. RECIPIENT PROJECT DIRECTOR *(Name and telephone No.)*
Chandler A. Swanberg (415)321-5662

10. TYPE OF AWARD
☒ NEW ☐ CONTINUATION ☐ RENEWAL
☐ REVISION ☐ SUPPLEMENT

9. RECIPIENT BUSINESS OFFICER *(Name and telephone No.)*
Mike Lyon (415)326-5470

12. ADMINISTERED FOR DOE BY *(Name, address, zip code, telephone No.)*
Ronald A. King (208)526-0790
U. S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83402

11. DOE PROJECT OFFICER *(Name, address, zip code, telephone No.)*
Susan Prestwich (208)526-1147
U.S.DOE, Idaho Operations Office
785 DOE Place, Idaho Falls, ID 83402

13. RECIPIENT TYPE
☐ STATE GOV'T ☐ INDIAN TRIBAL GOV'T ☐ HOSPITAL ☒ FOR PROFIT ORGANIZATION ☐ INDIVIDUAL
☐ LOCAL GOV'T ☐ INSTITUTION OF HIGHER EDUCATION ☐ OTHER NONPROFIT ORGANIZATION ☒ C ☐ P ☐ SP ☐ OTHER *(Specify)*

14. ACCOUNTING AND APPROPRIATIONS DATA

a. Appropriation Symbol	b. B & R Number	c. FT/AFP/OC	d. CFA Number
89X0224.19	AM101510	ID-54-91/250	

15. EMPLOYER I.D. NUMBER/SSN

16. BUDGET AND FUNDING INFORMATION

a. CURRENT BUDGET PERIOD INFORMATION

(1) DOE Funds Obligated This Action	$ 212,580
(2) DOE Funds Authorized for Carry Over	$ -0-
(3) DOE Funds Previously Obligated in this Budget Period	$ -0-
(4) DOE Share of Total Approved Budget	$ 212,580
(5) Recipient Share of Total Approved Budget	$ 216,875
(6) Total Approved Budget	$ 429,455

b. CUMULATIVE DOE OBLIGATIONS

(1) This Budget Period *[Total of lines a.(1) and a.(3)]*	$ 212,580
(2) Prior Budget Periods	$ -0-
(3) Project Period to Date *[Total of lines b. (1) and b. (2)]*	$ 212,580

17. TOTAL ESTIMATED COST OF PROJECT $ 429,455

(This is the current estimated cost of the project. It is not a promise to award nor an authorization to expend funds in this amount.)

18. AWARD/AGREEMENT TERMS AND CONDITIONS

This award/agreement consists of this form plus the following:

a. Special terms and conditions (if grant) or schedule, general provisions, special provisions (if cooperative agreement)

b. Applicable program regulations *(specify)* N/A *(Date)* _____

c. DOE Assistance Regulations, 10 CFR Part 600, as amended, Subparts A and ☐ B (Grants) or ☒ C (Cooperative Agreements).

d. Application/proposal dated 4/23/85, ☐ as submitted ☒ with changes as negotiated

19. REMARKS

This Agreement consists of this NFAA, Schedule Articles, General Provisions, Appendix A - Statement of Work, Appendix B - Labor Determination, DOE Order 1332.2, and Cost Principles FAR 31.2.

20. EVIDENCE OF RECIPIENT ACCEPTANCE

Chandler A. Swanberg 9/30/85
(Signature of Authorized Recipient Official) *(Date)*

Chandler A. Swanberg
(Name)

Vice President, Non-Geysers Project Manager
(Title)

21. AWARDED BY

William C. Drake 9/23/85
(Signature) *(Date)*

William C. Drake
(Name)

Contracting Officer
(Title)

SCHEDULE ARTICLES

ARTICLE I - STATEMENT OF JOINT OBJECTIVE

The purpose of this Cooperative Agreement between the United States Department of Energy (DOE or Government) and GEO Operator Corporation (GEO) (Participant) is to conduct research on the geothermal resources of the Cascades volanic region. This action is authorized by Federal Law and is in furtherance of the U. S. Government's objectives to (a) stimulate development of the region by making data publicly available which will characterize the geothermal resource and, (b) increase knowledge of both applicable exploration techniques and the depth required to penetrate the rain curtain.

ARTICLE II - THE PROJECT MANAGEMENT PLAN

A. Participant's Responsibilities. The Participant shall furnish the materials, facilities, equipment, personnel, services, and all other necessary and related items for the drilling of, data collection from, and plugging and abandonment of a deep thermal gradient hole located at Site N-3, 4100 feet north and 500 feet east of the southwest corner of Section 24, T20S, R12E, Deschutes County, Oregon. Requirements of the project are further set forth in Appendix A to this Agreement which is titled "STATEMENT OF WORK" and which is made a part hereof by this reference. The Participant shall provide the funding and reports as specifically provided for elsewhere in this Agreement, and obtain all necessary licenses and permits.

B. DOE's Responsibilities. DOE will provide a specified amount of financial assistance, will monitor the project as specified in C. below, and will act upon the Participant's requests for approval in those instances in which DOE's approval is required.

C. DOE Project Monitoring. DOE will closely monitor the performance of work under the cooperative agreement. This monitoring shall include: frequent telephone communications; site visits with frequency and duration as dictated by program needs; onsite monitoring; participation in program review meetings; review of specified program reports; determination that milestones are satisfactorily accomplished; and generally handling routine contract administration activities as necessary to maintain the program budget and schedule within established limits.

In addition, DOE may assign an on-site or resident technical monitor for a portion of the program performance. The principal responsibility of the resident technical monitor will be to maintain frequent communications regarding project technical progress status with DOE program and project management personnel. Details regarding the resident technical monitor's accommodations at the project site(s), his duties and responsibilities, etc. shall be negotiated if and when DOE chooses to assign such a monitor. The monitor's rights of access to the Participants' facilities are as provided for in Schedule Article VIII, paragraph A in the General Provisions, Item 3, INSPECTION, and in the Statement of Work.

ARTICLE IV - PAYMENTS (Cont'd)

Phase II - Evaluation

2. Submittal of the following Phase II items:

a. Geophysical data-fluids - Geochem
b. Geochemical data-rocks
c. Age data
d. Petrographic analysis
e. Mercury survey
f. Splits of core, cuttings, fluids, etc.
g. Final temperature log
h. Plug and abandonment plan
i. Project status and management reports
j. Other reports as required
k. Other data collected during Phase II
l. All reports written during Phase II

DOE access to site. $180,988.66

Phase III - Technology Transfer

3. Submittal of the following Phase III items:

a. Final Project Report
b. Project Status and Management Reports
c. Other reports as required
d. Other remaining data and miscellaneous items.

Total Maximum Payable by DOE $212,580.00

Payments approximate costs associated with respective phases but do not exactly correspond. This schedule is for progress payments only; actual allowable costs will be determined in accordance with Article III and General Provisions No. 29.

ARTICLE V - PAYMENT METHODS

A. Four copies of invoices shall be submitted to the address specified on Block 12 of the NFAA (DOE Form 4600.1).

B. Payments due for amounts properly invoiced in accordance with the terms and conditions specified elsewhere in the Cooperative Agreement shall be made either by Treasury check(s) payable to the Participant or by electronic funds transfer(s) to a financial institution designated by the Participant. The method of payment shall be determined by the Government at the time of payment in accordance with applicable Department of Treasury requirements.

ARTICLE III - FINANCIAL SUPPORT

A. Estimated Cost. The total estimated cost of the work under this Agreement is Four Hundred Twenty-Nine Thousand Four Hundred Fifty-Five Dollars ($429,455). For performance of work under this Agreement, the agreed share ratio of total allowable costs is 49.5% DOE and 51.5% Participant. The Participant shall be reimbursed by DOE for not more than 49.5% of the costs of the project determined to be allowable in accordance with General Provisions, Section 29, entitled "Allowable Costs." The remaining 51.5% of the cost of the project so determined shall constitute the Participant's share for which it will not be reimbursed by DOE. If at any time the Participant has reason to believe that this or any revised estimate is in error, the Participant shall so notify DOE in writing and provide DOE with a new estimate with the next monthly Federal Assistance Management Summary Report. = 101%

B. DOE's Financial Support. The total cost to DOE for all the work under this project is Two Hundred Twelve Thousand Five Hundred Eighty Dollars ($212,580), and under no circumstances will DOE's support exceed this amount. This limitation includes termination costs, if any.

C. Participant's Financial Support. All costs in excess of the Two Hundred Twelve Thousand Five Hundred Eighty Dollars ($212,580) to be provided by DOE will be borne by the Participant. The estimated cost to the Participant is Two Hundred Sixteen Thousand Eight Hundred Seventy-Five Dollars ($216,875).

D. Obligated Funds. The amount of funds presently obligated to this Agreement by DOE is Two Hundred Twelve Thousand Five Hundred Eighty Dollars ($212,580).

ARTICLE IV - PAYMENTS

Progress Payments will be made on the basis of allowable costs incurred subject to the applicable cumulative ceiling. Invoices shall be submitted to DOE upon completion of each milestone.

Milestone	Maximum Cumulative Amount Payable by DOE
Phase I - Drilling	
1. Submittal of the following Phase I data:	
a. Geophysical logs	
b. Temperature logs	
c. Lithographic logs ← Lithologic	
d. Drillers log	
e. Hole completion schematic	
f. Temperatures measured during drilling	
g. Hydraulic head data taken during drilling	
h. Other data collected during Phase I	$158,439.57

ARTICLE V - PAYMENT METHODS (Cont'd)

C. After award but no later than fourteen (14) days before an invoice or bill is submitted for payment, the Participant shall designate a financial institution for the receipt of electronic funds transfer payments hereunder; and provide the appropriate Government representative (Contracting Officer or finance official as determined by the Government) with the name of the designated financial institution, financial institution's or correspondent financial institution's 9-digit American Bankers Association identifying number, telegraphic abbreviation of such financial institution, and account number at the designated financial institution to be credited with the funds.

D. In the event the Participant during the performance of this Cooperative Agreement elects to designate a different financial institution for the receipt of any payment made using electronic funds transfer procedures, notification of such change and the information as specified in paragraph B. above must be received by the appropriate Government representative thirty (30) days prior to the date such change is to become effective.

E. Participant failure to properly designate a financial institution or to provide appropriate payee bank account information may delay payments of amounts otherwise properly due.

ARTICLE VI - TERM OF THE AGREEMENT

The work under this Agreement shall be completed by January 31, 1987 or within any extension of time as may be mutually agreed to in writing by the parties.

ARTICLE VII - PROJECT INFORMATION SYSTEM

The Federal assistance recipient shall prepare and submit (postage prepaid) the plans and reports indicated on the Federal Assistance Reporting Checklist (Appendix A) to the addresses and in the number of copies designated on the checklist. Preparation of the specified plans and reports shall be in accordance with the attached DOE Order 1332.2, Uniform Reporting System for Federal Assistance (grants and cooperative agreements). The level of detail the recipient provides in the plans and reports shall be commensurate with the scope and complexity of the task and shall be as delineated in Block 4 - Reporting Requirements - and Block 5 - Special Instructions. The prime recipient shall be responsible for acquiring data from any subcontractors, or subrecipients to ensure that data submitted are compatible with the data elements which prime recipients submit to DOE. Plans and reports submitted in compliance with this provision are in addition to any other reporting requirements of the Federal assistance instrument.

ARTICLE VII - PROJECT INFORMATION SYSTEM (Cont'd)

All reports after delivery to DOE shall be the sole property of the DOE. The Participant shall not claim that any report contains any trade secrets or commercial or financial information deemed by the Participant to be privileged or confidential, or that the Participant has any proprietary interest in any report.

ARTICLE VIII - RESPONSIBLE PERSONS AND PERSONNEL

A. The Participant agrees to permit any specified DOE personnel or designated DOE Contractor personnel to have necessary access to the Participants and/or major subcontractor's facilities, personnel, and records pertaining to the project. Such DOE contractor personnel may be used to assist the Program Officer in carrying out his responsibilities.

B. The Contracting Officer has the responsibility/authority for executing, amending, and terminating award instruments. In addition, the contracting Officer, or designee, has the responsibility for: conducting negotiations concerning the statement of work, costs, and schedule; administration of the agreement; arranging for audits, as appropriate, and resolving audit findings; assuring policies and procedures are implemented, approving payments, and taking actions required to close-out the agreement.

C. The Program Officer is DOE's technical representative for the Agreement and has the following responsibilities: monitors and assesses the status of progress toward achieving the program milestones and objectives; reviews and evaluates all technical reports prepared by the Participant; represents DOE at program review meetings; reviews cost vouchers; and coordinates with the Participant in choosing among alternatives for future program activities. The Program Officer will be assisted by designated DOE Contractor personnel in carrying out these repsponsibilities.

D. The Program Officer for DOE under this Agreement, and the person who shall be the Participant's contact for all technical matters pertaining to this Agreement shall be the person named below or such other person as may be designated in writing by the Contracting Officer:

Susan Prestwich

E. The representative for the Participant for the purposes of this Agreement shall be the person named below or such other person as may be designated in writing by the Participant:

Chandler Swanberg

ARTICLE IX - PUBLIC INFORMATION RELEASES

The parties agree that public disclosure or dissemination of new data or information arising out of the design, construction or operation of the project will be coordinated by the parties, it being understood that the intent of both the Participant and DOE is to release all data and information to the greatest practicable extent in order to achieve the objective of obtaining maximum public value from the results of this project. It is understood that the foregoing is not intended to afford either party the right to prevent a public release by the other; however, nothing in this article shall impair the rights of the parties set forth elsewhere in this Agreement, including but not necessarily limited to General Provision 20 entitled "Patent Rights - Long Form".

ARTICLE X - ORGANIZATIONAL CONFLICTS OF INTEREST - GENERAL

A. The Participant warrants that, to the best of its knowledge and belief, and except as otherwise disclosed, there are no relevant facts which could give rise to organizational conflicts of interest, as defined in DEAR Subpart 909.5 or that the Participant has disclosed all relevant information.

B. The Participant agrees that, if after award, an organizational conflict of interest with respect to this Agreement is discovered, an immediate and full disclosure in writing shall be made to the Contracting Officer which shall include a description of the action which the Participant has taken or proposes to take to avoid or mitigate such conflicts. The Department may, however, terminate the Agreement for its convenience if it deems such termination to be in the best interest of the Government.

C. In the event that the Participant was aware of an organizational conflict of interest prior to the award of this Agreement and did not disclose the conflict to the Contracting Officer, the Government may terminate the Agreement for default.

D. The provisions of this article shall be included in all subagreements for work to be performed similar to the services provided by the Participant, and the terms "Agreement," "Participant," and "Contracting Officer" modified appropriately to preserve the Government's rights.

ARTICLE XI - DATE OF INCURRENCE OF COSTS

The Participant shall be entitled to reimbursement of costs incurred in an amount not to exceed $105,000 on or after August 22, 1985, which, if incurred after this Cooperative Agreement has been entered into, would have been reimbursable under the provisions of this Cooperative Agreement.

ARTICLE XII - LIABILITIES

DOE shall not be liable for damages to persons or property incurred by the Participant or its subcontractors in the performance of work under this Agreement. The Participant shall maintain financial coverage for potential liability as agreed upon by the Participant and the Contracting Officer.

GENERAL PROVISIONS FOR

COOPERATIVE AGREEMENTS

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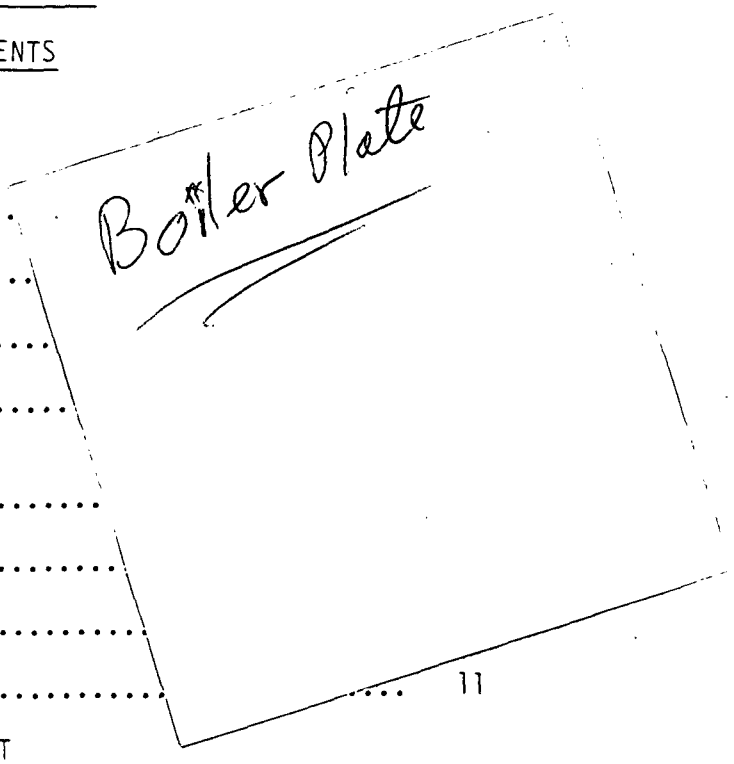

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GENERAL PROVISIONS

COOPERATIVE AGREEMENT

1. ORDER OF PRECEDENCE (DEAR 952.215-18) (APR 1984)

In the event of an inconsistency between provisions of this Cooperative Agreement, the inconsistency shall be resolved by giving precedence as follows: (a) schedule; (b) agreement clauses or (c) other provisions of the agreement, whether incorporated by reference or otherwise.

2. DEFINITIONS (DEAR 952.202-1) (APR 1984)

(a) The term "Head of Agency" means the Secretary, the Deputy Secretary, or Under Secretary of the Department of Energy.

(b) "Contracting Officer" means a person with the authority to enter into, administer, and/or terminate contracts and make related determination and findings. The term includes, certain authorized representatives of the Contracting Officer acting within the limits of their authority as delegated by the Contracting Officer.

(c) Except as otherwise provided in this agreement, the term "subcontracts" includes but is not limited to, purchase orders and changes and modifications to purchase orders under this agreement.

(d) The term "DOE" means the Department of Energy.

(e) The terms "contract" and "Contractor" mean agreement and Participant respectively.

3. INSPECTION OF RESEARCH AND DEVELOPMENT-SHORT FORM (FAR 52.246-9) (APR 1984)

The Government has the right to inspect and evaluate the work performed or being performed under the agreement, and the premises where the work is being performed, at all reasonable times and in a manner that will not unduly delay the work. If the Government performs inspection or evaluation on the premises of the Participant or a subcontractor, the Participant shall furnish and shall require subcontractors to furnish all reasonable facilities and assistance for the safe and convenient performance of these duties.

4. RIGHTS TO PROPOSAL DATA (DEAR 952.227-82) (APR 1984)

Except for technical data contained on pages (none) of the Contractor's proposal dated (none) which are asserted by the Contractor as being proprietary data, it is agreed that, as a condition of the award of this contract, and notwithstanding the provisions of any notice appearing on the proposal, the Government shall have the right to use, duplicate, disclose and have others do so for any purpose whatsover, the technical data contained in the proposal upon which this contract is based.

5. EXAMINATION OF RECORDS BY COMPTROLLER GENERAL (10 CFR 600.25)

(a) Recipient records. DOE and the Comptroller General of the United States, or any of their authorized representatives, shall have the right of access to any books, documents, papers, or other records of a recipient that are directly perinent to the DOE financial assistance award, in order to make audit, examination, excerpts, and transcripts.

(b) Subrecipient records. DOE, the Comptroller General of the United States, and the recipient, or any of their authorized representatives, shall have the right of access to any books, documents, papers, or other records of a subrecipient which are directly pertinent to the financial assistance subaward, in order to make audit, examination, excerpts, and transcripts.

(c) Contractor and subcontractor records. With respect to any negotiated contract or subcontract in excess of $10,000 under a grant or cooperative agreement, DOE, the Comptroller General of the United States, the recipient and (if the contract was awarded under a financial assistance subaward) the subrecipient, or any of their authorized representatives shall have the right of access to any books, documents, papers, or other records of the contractor or subcontractor which are directly pertinent to that contract or subcontract, in order to make an audit examination, excerpts, and transcripts.

(d) Duration of access right. The right of access may be exercised for as long as the applicable records are retained by the recipient, subrecipient, contractor, or subcontractor (See § 600.124 and § 600.271 for record retention requirements for grants and cooperative agreements, respectively.)

6. CONVICT LABOR (FAR 52.222-3) (APR 1984)

The Participant agrees not to employ any person undergoing sentence of imprisonment in performing this agreement except as provided by 18 U.S.C. 4082(c)(2) and Executive Order 11755, December 29, 1973.

7. OFFICIALS NOT TO BENEFIT (FAR 52.203-1) (APR 1984)

No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit arising from it. However, this clause does not apply to this agreement to the extent that this agreement is made with a corporation for the corporation's general benefit.

8. COVENANT AGAINST CONTINGENT FEES (FAR 52.203-5) (APR 1984)

(a) The Participant warrants that no person or agency has been employed or retained to solicit or obtain this agreement upon an agreement or understanding for a contingent fee, except a bona fide employee or agency. For breach or violation of this warranty, the Government shall have the right

8. COVENANT AGAINST CONTINGENT FEES (FAR 52.203-5) (APR 1984) (Cont'd)

to annul this agreement without liability or, in its discretion, to deduct from the agreement price or consideration, or otherwise recover, the full amount of the contingent fee.

(b) "Bona fide agency," as used in this clause, means an established commercial or selling agency, maintained by a participant for the purpose of securing business, that neither exerts nor proposes to exert improper influence to solicit or obtain Government agreements nor hold itself out as being able to obtain any Government agreement or agreements through improper influence.

"Bona fide employee," as used in this clause, means a person, employed by a participant and subject to the participant's supervision and control as to time, place, and manner of performance, who neither exerts nor proposes to exert improper influence to solicit or obtain Government agreements nor holds out as being able to obtain any Government agreement or agreements through improper influence.

"Contingent fee," as used in this clause, means any commission, percentage, brokerage, or other fee that is contingent upon the success that a person or concern has in securing a Government agreement.

"Improper influence," as used in this clause, means any influence that induces or tends to induce a Government employee or officer to give consideration or to act regarding a Government agreement on any basis other than the merits of the matter.

9. NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT (41 CFR 9-9.104)

The provisions of this clause shall be applicable only if the amount of this agreement exceeds $10,000.

(a) The participant shall report to the Contracting Officer, promptly and in reasonable written detail, each notice of claim of patent or copyright infringement based on the performance of this agreement of which the participant has knowledge.

(b) In the event of any claim or suit against the Government on account of any alleged patent or copyright infringement arising out of the performance of this agreement or out of the use of any supplies furnished or work or services preformed hereunder, the participant shall furnish to the Government when requested by the Contracting Officer, all evidence and information in possession of the participant petaining to such suit or claim. Such evidence and information shall be furnished at the expense of the Government except where the participant has agreed to indemnify the Government.

(c) This clause shall be included in all contracts and subagreements under the agreement.

10. COMPETITION IN SUBCONTRACTING (FAR 52.244-5) (APR 1984)

The Participant shall select subcontractors (including suppliers) on a competitive basis to the maximum practical extent consistent with the objectives and requirements of the agreement.

11. AUDIT-NEGOTIATION (FAR 52.215-2) (APR 1984)

(a) Examination of costs. If this is a cost-reimbursement, incentive, time and materials, labor-hour, or price-redeterminable agreement, or any combination of these, the Participant shall maintain and the Contracting Officer or representatives of the Contracting Officer shall have the right to examine and audit books, records, documents, and other evidence and accounting procedures and practices, sufficient to reflect properly all costs claimed to have been incurred or anticipated to be incurred in performing this agreement. This right of examination shall include inspection at all reasonable times of the Participant's plants, or parts of them, engaged in performing the agreement.

(b) Cost or pricing data. If, pursuant to law, the Participant has been required to submit cost or pricing data in connection with pricing this agreement or any modification to this agreement, the Contracting Officer or representatives of the Contracting Officer who are employees of the Government shall have the right to examine and audit all books, records, documents, and or data of the Participant (including computations and projections) related to negotiating, pricing, or performing the agreement or modification, in order to evaluate the accuracy, completeness, and currency of the cost or pricing data submitted, along with the computations and projection used.

(c) Reports. If the Participant is required to furnish cost, funding, or performance reports, the Contracting Officer or representatives of the Contracting Officer who are employees of the Government shall have the right to examine and audit books, records, other documents and supporting materials, for the purpose of evaluating (1) the effectiveness of the Participant's policies and procedures to produce data compatible with the objectives of these reports and (2) the data reported.

(d) Availability. The Participant shall make available at its office at all reasonable times the materials described in paragraphs (a) and (b) above, for examination, audit, or reproduction, until 3 years after final payment under this agreement, or for any shorter period specified in Subpart 4.7, Contractor Records Retention, of the Federal Acquisition Regulation, or for any longer period required by statute or by other clauses of this agreement. In addition:

(1) If this agreement is completely or partially terminated, the records relating to the work terminated shall be made available for 3 years after any resulting final termination settlement; and

11. AUDIT-NEGOTIATION (FAR 52.215-2) (APR 1984) (Cont'd)

(2) Records relating to appeals under the Disputes clause or to litigation or the settlement of claims arising under or relating to this agreement shall be made available until such appeals, litigation, or claims are disposed of.

(e) The Participant shall insert a clause containing all the terms of this clause, including this paragraph (e), in all subcontracts over $10,000 under this agreement, altering the clause only as necessary to identify properly the contracting parties and the Contracting Officer under the Government prime agreement.

12. CLEAN AIR AND WATER (10 CFR 600.12) 13. PREFERENCE FOR U.S. FLAG CARRIERS (10 CFR 600.12) 14. USE OF U.S. FLAG COMMERCIAL VESSELS (10 CFR 600.12)

(a) "Generally applicable requirement" means Federal policies of administrative requirements that apply to (1) more than one DOE financial assistance award, or (2) a DOE financial assistance program and one or more other Federal assistance programs. Generally applicable requirements include, but are not limited to, the requirements of this Part, Federal statutes, the OMB Circulars and other governmentwide guidance implemented by this Part, Executive Orders, and the requirements identified in Appendix A of this Part.

(b) Except as expressly exempted by Federal statute or program rule, recipients and subrecipients of DOE financial assistance shall comply with all generally applicable requirements to which, by the terms of such requirements, they are subject. DOE may require the submission of preaward assurances of compliance with one or more generally applicable requirements and may conduct preaward and postaward compliance reviews only to the extent such actions are authorized by this Part, Federal statute or rule, Executive Order, or OMB directive.

15. PERMITS AND RESPONSIBILITIES (52.236-7) (APR 1984)

The Participant shall, without additional expense to the Government, be responsible for obtaining any necessary licenses and permits, and for complying with and Federal, State, and muncipal laws, codes, and regulations applicable to the performance of the work. The Participant shall also be responsible for all damages to persons or property that occur as a result of the Participant's fault or negligence, and shall take proper safety and health precautions to protect the work, the workers, the public, and the property of others. The Participant shall also be responsible for all materials delivered and work performed untill completion and acceptance of the entire work, except for any completed and acceptance of the entire work, except for any completed unit of work which may have been accepted under the agreement.

16. REPORTING OF ROYALTIES (41 CFR 9-9.110)

If this agreement is in an amount which exceeds $10,000 and if any royalty payments are directly involved in the agreement or are reflected in the amount of the agreement award, the participant agrees to report in writing to the Patent Counsel (with notification by Patent Counsel to the Contracting Officer) during the performance of this agreement and prior to its completion or closeout, the amount of any royalties or other payments paid or to be paid by it directly to others in connection with the performance of this agreement together with the names and addresses of licensors to whom such payments are made and either the patent numbers involved or such other information as will permit the identification of the patents or other basis on which the royalties are to be paid. The approval of DOE of any individual payments or royalties shall not stop the Government at any time from contesting the enforceability, validity, or scope of, or title to, any patent under which a royalty or payments are made.

17. AUTHORIZATION AND CONSENT (41 CFR 9-9.102-2)

The Government hereby gives its authorization and consent for all use and manufacture of any invention described in and covered by a patent of the United States in the performance of this agreement or any part hereof or any amendment hereto or any subcontract hereunder (including all lower-tier subcontracts).

18. NONDISCRIMINATION IN FEDERALLY ASSISTED PROGRAMS (10 CFR Part 1040)

The Participant agrees that no person in the United States shall, on the ground of race, color or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity for which the Participant receives Federal financial assistance from DOE.

19. RIGHTS IN TECHNICAL DATA - LONG FORM (DEAR 952.227-75)

(a) Definitions.

(1) "Technical Data" means recorded information regardless of form or characteristic, of a scientific or technical nature. It may, for example, document research, experimental, developmental, or demonstration, or engineering work, or be usable or used to define a design or process, or to procure, produce, support, maintain, or operate material. The data may be graphic or pictorial delineations in media such as drawings or photographs, text in specifications or related performance or design type documents or computer software (including computer programs, computer software data bases, and computer software documentation). Examples of technical data include research and engineering data, engineering drawings and associated lists, specifications, standards, process sheets, manuals, technical reports,

19. RIGHTS IN TECHNICAL DATA - LONG FORM (DEAR 952.227-75) (Cont'd)

catalog item identification, and related information. Technical data as used herein does not include financial reports, cost analyses, and other information incidental to agreement administration.

(2) "Proprietary Data" means technical data which embody trade secrets developed at private expense, such as design procedures or techniques, chemical composition of materials, or manufacturing methods, processes, or treatments, including minor modifications thereof, provided that such data:

(i) Are not generally known or available from other sources without obligation concerning their confidentiality;

(ii) Have not been made available by the owner to others without obligation concerning its confidentiality; and

(iii) Are not already available to the Government without obligation concerning their confidentiality.

(3) "Contract Data" means technical data first produced in the performance of the agreement, technical data which are specified to be delivered in the agreement, technical data that may be called for under the "Additional Technical Data Requirements" article of the agreement, if any, or technical data actually delivered in connection with the agreement.

(4) "Unlimited Rights" means rights to use, duplicate, or disclose technical data, in whole or in part, in any manner and for any purpose whatsoever, and to permit others to do so.

(b) Allocation of Rights.

(1) The Government shall have:

(i) Unlimited rights in contract data except as otherwise provided below with respect to proprietary data.

(ii) The right to remove, cancel, correct or ignore any marking not authorized by the terms of this agreement on any technical data furnished hereunder, if in response to a written inquiry by DOE concerning the propriety of the markings, the Participant fails to respond thereto within sixty (60) days or fails to substantiate the propriety of the markings. In either case DOE will notify the Participant of the action taken.

19. RIGHTS IN TECHNICAL DATA - LONG FORM (DEAR 952.227-75) (Cont'd)

(iii) No rights under this Agreement in any technical data which are not contract data.

(2) The Participant shall have:

(i) The right to withhold proprietary data in accordance with the provisions of this clause.

(ii) The right to use for its private purposes, subject to patent, security or other provisions of this agreement, contract data it first produces in the performance of this agreement provided the data requirements of this agreement have been met as of the date of the private use of such data. The Participant agrees that to the extent it receives or is given access to proprietary data or other technical, business or financial data in the form of recorded information from DOE or a DOE contractor or subcontractor, the Participant shall treat such data in accordance with any restrictive legend contained thereon, unless use is specifically authorized by prior written approval of the Contracting Officer.

(3) Nothing contained in this "Rights in Technical Data" clause shall imply a license to the Government under any patent or be construed as affecting the scope of any licenses or other rights otherwise granted to the Government under any patent.

(c) Copyrighted Material.

(1) The Participant shall not, without prior written authorization of the Contracting Officer, establish a claim to statutory copyright in any agreement data first produced in the performance of the agreement. To the extent such authorization is granted, the Government reserves for itself and others acting on its behalf a royalty-free, nonexclusive, irrevocable, worldwide license for Governmental purposes to publish, distribute, translate, duplicate, exhibit and perform any such data copyrighted by the Participant.

(2) The Participant agrees not to include in the technical data delivered under the agreement any material copyrighted by the Participant and not to knowingly include any material copyrighted by others without first granting or obtaining at no cost a license therein for the benefit of the Government of the same scope as set forth in subparagraph (c)(1) above. If such royalty-free license is unavailable and the Participant nevertheless determines that such copyrighted material must be included in the technical data to be delivered, rather than merely incorporated therein by reference, the Participant shall request the written authorization of the Contracting Officer to include such copyrighted material in the technical data without a license.

19. RIGHTS IN TECHNICAL DATA - LONG FORM (DEAR 952.227-75) (Cont'd)

(d) Subcontracting. It is the responsibility of the Participant to obtain from its subcontractors technical data and rights therein, on behalf of the Government, necessary to fulfill the Participant's obligations to the Government with respect to such data. In the event of refusal by a subcontractor to accept a clause affording the Government such rights, the Participant shall:

(1) Promptly submit written notice to the Contracting Officer setting forth reasons for the subcontractor's refusal and other pertinent information which may expedite disposition of the matter; and

(2) Not proceed with the subcontract without the written authorization of the Contracting Officer.

(e) Withholding of Proprietary Data. Notwithstanding the inclusion of the "Additional Technical Data Requirements" clause in this agreement or any provision of this agreement specifying the delivery of technical data, the Participant may withhold proprietary data from delivery, provided that the Participant furnishes in lieu of any such proprietary data so withheld, technical data disclosing the source, size, configuration, mating and attachment characteristics, functional characteristics and performance requirements ("Form, Fit and Function" data, e.g., specification control drawings, catalog sheets, envelope drawings, etc.), or a general description of such proprietary data where "Form, Fit and Function" data are not applicable. The Government shall acquire no rights to any proprietary data so withheld except that such data shall be subject to the "Inspection Rights" provisions of paragraph (f), and, if included, the "Limited Rights in Proprietary Data" provisions of paragraph (g) and the "Participant Licensing" provisions of paragraph (h)

(f) Inspection Rights. Except as may be otherwise specified in this agreement for specific items of proprietary data which are not subject to this paragraph, the Contracting Officer's representatives, at all reasonable times up to three (3) years after final payment under this agreement, may inspect at the Participant's facility any proprietary data withheld under paragraph (c) for the purposes of verifying that such data properly fell within the withholding provision of paragraph (e), or for evaluating work performance.

20. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT - OVERTIME COMPENSATION - GENERAL (FAR 52.222-4) (APR 1984)

This agreement, to the extent that it is of a character specified in the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333), is subject to the following terms and all other applicable provisions and exceptions of the Act and the regulations of the Secretary of Labor.

(a) Overtime Requirements. The Participant or contractor shall not require or permit any laborer or mechanic to work in excess of 8 hours in any calendar day, or 40 hours in any workweek, any part of the agreement work

20. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT - OVERTIME COMPENSATION - GENERAL (FAR 52.222-4) (APR 1984) (Cont'd)

subject to the Act; unless, the laborer or mechanic receives compensation at a rate not less than 1 1/2 times the basic rate of pay for all hours worked in excess of 8 hours in any calendar day, or 40 hours in any workweek, whichever produces the greater amount of overtime.

(b) Violation, Liability for Unpaid Wages, and Liquidated Damages. If the terms of paragraph (a) above are violated, the Participant and any subcontractor responsible for the violation shall be liable to any affected employee for unpaid wages. In addition, the Participant and subcontractor shall be liable to the United States for liquidated damages. These damages are computed for each individual laborer or mechanic at $10 for each calendar day on which the employee was required or permitted to be employed in violation of paragraph (a) above.

(c) Withholding for Unpaid Wages and Liquidated Damages. The Contracting Officer may withhold from the Participant, from any moneys payable on account of work performed by the Participant or subcontractor, such amounts as may administratively be determined to be necessary to satisfy any liabilities of the Participant or subcontractor for unpaid wages and liquidated damages as provided in paragraph (b) above.

(d) Subcontracts. The Participant and subcontractor shall insert paragraphs (a) through (d) of this clause in all subcontracts.

(e) Records. The Participant shall maintain payroll records containing the information specified in 29 CFR 516.2(a). These records shall be preserved for 3 years from agreement completion. The Participant will make the records available for inspection by authorized representatives of the Department of Energy and the Department of Labor, and will permit such representatives to interview employees during working hours on the job.

21. PATENT RIGHTS - LONG FORM (41 CFR 9-9.107-5(a))

(a) Definitions.

(1) "Subject Invention" means any invention or discovery of the Participant conceived or first actually reduced to practice in the course of or under this agreement, and includes any art, method, process, machine, manufacture, design, or composition of matter, or any new and useful improvement thereof, or any variety of plants, whether patented or unpatented under the Patent Laws of the United States of America or any foreign country.

(2) "Contract" means any contract, grant, agreement, understanding or other arrangement, which includes research, development, or demonstration work, and includes any assignment or substitution of parties.

21. PATENT RIGHTS - LONG FORM (Cont'd)

(3) "States and domestic municipal governments" means the States of the United States, the District of Columbia, Puerto Rico, the Virgin Islands, American Samoa, Guam, the Trust Territory of the Pacific Islands, and any political subdivision and agencies thereof.

(4) "Government agency" includes an executive department, independent commission, board, office, agency, administration, authority, Government corporation, or other Government establishment of the Executive Branch of the Government of the United States of America.

(5) "To the point of practical application" means to manufacture in the case of a composition or product, to practice in the case of a process, or to operate in the case of a machine and under such conditions as to establish that the invention is being worked and that its benefits are reasonably accessible to the public.

(6) "Patent Counsel" means the DOE Patent Counsel assisting the procuring activity.

(b) Allocation of Principal Rights.

(1) Assignment to the Government. The Participant agrees to assign to the Government the entire right, title, and interest throughout the world in and to each Subject Invention except to the extent that rights are retained by the Participant under subparagraph (b)(2) and paragraph (c) of this clause.

(2) Greater Rights Determinations. The Participant or the employee-inventor with authorization of the Participant may request greater rights than the nonexclusive license and the foreign patent rights provided in paragraph (c) of this clause on identified inventions, in accordance with 41 CFR 9-9.109-6. Such requests must be submitted to Patent Counsel (with notification by Patent Counsel to the Contracting Officer) at the time of the first disclosure pursuant to subparagraph (e)(2) of this clause, or not later than nine (9) months after conception or first actual reduction to practice, whichever occurs first, or such longer period as may be authorized by Patent Counsel (with notification by Patent Counsel to the Contracting Officer) for good cause shown in writing by the Participant.

(c) Minimum Rights to the Participant.

(1) Participant License. The Participant reserves a revocable, nonexclusive, paid-up license in each patent application filed in any country on a Subject Invention and any resulting patent in which the Government acquires title. The license shall extend to the Participant's domestic subsidiaries and affiliates, if any, within the corporate structure of which the Participant is a part and shall include the right to grant sublicenses of the same scope to the extent the Participant was

21. PATENT RIGHTS - LONG FORM (Cont'd)

legally obligated to do so at the time the agreement was awarded. The license shall be transferable only with approval of DOE except when transferred to the successor of that part of the Participant's business to which the invention pertains.

(2) Revocation Limitations. The Participant's nonexclusive license retained pursuant to subparagraph (c)(1) of this clause and sublicenses granted thereunder may be revoked or modified by DOE, either in whole or in part, only to the extent necessary to achieve expeditious practical application of the Subject Invention under DOE's published licensing regulations (10 CFR 781), and only to the extent an exclusive license is actually granted. This license shall not be revoked in that field of use and/or the geographical areas in which the Participant, or its sublicensee, has brought the invention to the point of practical application and continues to make the benefits of the invention reasonably accessible to the public, or is expected to do so within a reasonable time.

(3) Revocation Procedures. Before modification or revocation of the license or sublicense, pursuant to subparagraph (c)(2) of this clause, DOE shall furnish the Participant a written notice of its intention to modify or revoke the license and any sublicense thereunder, and the Participant shall be allowed thirty (30) days, or such longer period as may be authorized by the Patent Counsel (with notification by Patent Counsel to the Contracting Officer) for good cause shown in writing by the Participant, after such notice to show cause why the license or any sublicense should not be modified or revoked. The Participant shall have the right to appeal, in accordance with 10 CFR 781, any decision concerning the modification or revocation of its license or any sublicense.

(4) Foreign Patent Rights. Upon written request to Patent Counsel (with notification by Patent Counsel to the Contracting Officer), in accordance with subparagraph (e)(2)(i) of this clause, and subject to DOE security regulations and requirements, there shall be reserved to the Participant, or the employee-inventor with authorization of the Participant, the patent rights to a Subject Invention in any foreign country where the Government has elected not to secure such rights provided:

(i) The recipient of such rights, when specifically requested by DOE and three (3) years after issuance of a foreign patent disclosing said Subject Invention, shall furnish DOE a report setting forth:

(A) The commercial use that is being made, or is intended to be made, of said invention, and

21. PATENT RIGHTS - LONG FORM (Cont'd)

(B) The steps taken to bring the invention to the point of practical application or to make the invention available for licensing.

(ii) The Government shall retain at least an irrevocable, nonexclusive, paid-up license to make, use, and sell the invention throughout the world by or on behalf of the Government (including any Government agency) and States and domestic municipal governments, unless the Secretary or his designee determines that it would not be in the public interest to acquire the license for the States and domestic municipal governments.

(iii) Subject to the rights granted in subparagraphs (c)(1), (2), and (3) of this clause, the Secretary or his designee shall have the right to terminate the foreign patent rights granted in this subparagraph (c)(4) in whole or in part unless the recipient of such rights demonstrates to the satisfaction of the Secretary or his designee that effective steps necessary to accomplish substantial utilization of the invention have been taken or within a reasonable time will be taken.

(iv) Subject to the rights granted in subparagraphs (c)(1), (2), and (3) of this clause, the Secretary or his designee shall have the right, commencing four (4) years after foreign patent rights are accorded under this subparagraph (c)(4), to require the granting of a nonexclusive or partially exclusive license to a responsible applicant or applicants, upon terms reasonable under the circumstances and in appropriate circumstances to terminate said foreign patent rights in whole or in part, following a hearing upon notice thereof to the public, upon a petition by an interested person justifying such hearing:

(A) If the Secretary or his designee determines, upon review of such material as he deems relevant, and after the recipient of such rights, or other interested person, has had the opportunity to provide such relevant and material information as the Secretary or his designee may require, that such foreign patent rights have tended substantially to lessen competition or to result in undue market concentration in any section of the United States in any line of commerce to which the technology relates; or

(B) Unless the recipient of such rights demonstrates to the satisfaction of the Secretary or his designee at such hearing that the recipient has taken effective steps, or within a reasonable time thereafter is expected to take such steps, necessary to accomplish substantial utilization of the invention.

21. PATENT RIGHTS - LONG FORM (Cont'd)

(d) Filing of Patent Applications.

(1) With respect to each Subject Invention in which the Participant or the inventor requests foreign patent rights in accordance with subparagraph (c)(4) of this clause, a request may also be made for the right to file and prosecute the U.S. application on behalf of the U.S. Government. If such request is granted, the Participant or inventor shall file a domestic patent application on the invention within six (6) months after the request for foreign patent rights is granted, or such longer period of time as may be approved by the Patent Counsel for good cause shown in writing by the requester. With respect to the invention, the requestor shall promptly notify the Patent Counsel (with notification by Patent Counsel to the Contracting Officer) of any decision not to file an application.

(2) For each Subject Invention on which a domestic patent application is filed by the Participant or inventor, the Participant or inventor shall:

(i) Within two (2) months after the filing or within two (2) months after submission of the invention disclosure if the patent application previously has been filed, deliver to the Patent Counsel a copy of the application as filed including the filing date and serial number;

(ii) Within six (6) months after filing the application or within six (6) months after submitting the invention disclosure if the application has been filed previously, deliver to the Patent Counsel a duly executed and approved assignment to the Government, on a form specified by the Government;

(iii) Provide the Patent Counsel with the original patent grant promptly after a patent is issued on the application; and

(iv) Not less than thirty (30) days before the expiration of the response period for any action required by the Patent and Trademark Office, notify the Patent Counsel of any decision not to continue prosecution of the application.

(3) With respect to each Subject Invention in which the Participant or inventor has requested foreign patent rights, the Participant or inventor shall file a patent application on the invention in each foreign country in which such request is granted in accordance with applicable statutes and regulations and within one of the following periods:

(i) Eight (8) months from the date of filing a corresponding United States application, or if such an application is not filed, six (6) months from the date the request was granted;

21. PATENT RIGHTS - LONG FORM (Cont'd)

(ii) Six (6) months from the date a license is granted by the Commissioner of Patents and Trademarks to file the foreign patent application where such filing has been prohibited by security reasons; or

(iii) Such longer periods as may be approved by the Patent Counsel for good cause shown in writing by the Participant or inventor.

(4) Subject to the license specified in subparagraphs (c)(1), (2) and (3) of this clause, the Participant or inventor agrees to convey to the Government, upon request, the entire right, title, and interest in any foreign country in which the Participant or inventor fails to have a patent application filed in accordance with subparagraph (d)(3) of this clause, or decides not to continue prosecution or to pay any maintenance fees covering the invention. To avoid forfeiture of the patent application or patent the Participant or inventor shall, not less than sixty (60) days before the expiration period for any action required by any Patent Office, notify the Patent Counsel of such failure or decision, and deliver to the Patent Counsel the executed instruments necessary for the conveyance specified in this paragraph.

(e) Invention Identification, Disclosures, and Reports.

(1) The Participant shall establish and maintain active and effective procedures to ensure that Subject Inventions are promptly identified and timely disclosed. These procedures shall include the maintenance of laboratory notebooks or equivalent records and any other records that are reasonably necessary to document the conception and/or the first actual reduction to practice of Subject Inventions, and records which show that the procedures for identifying and disclosing the inventions are followed. Upon request, the Participant shall furnish the Contracting Officer a description of these procedures so that he may evaluate and determine their effectiveness.

(2) The Participant shall furnish the Patent Counsel (with notification by Patent Counsel to the Contracting Officer) on a DOE-approved form:

(i) A written report containing full and complete technical information concerning each Subject Invention within six (6) months after conception or first actual reduction to practice whichever occurs first in the course of or under this Agreement, but in any event prior to any on sale, public use or public disclosure of such invention known to the Participant. The report shall identify the Agreement and inventor and shall be sufficiently complete in technical detail and appropriately illustrated by sketch or diagram to convey to one skilled in the art to which the invention pertains a clear understanding of the nature, purpose, operation, and to the

21. PATENT RIGHTS - LONG FORM (Cont'd)

extent known, the physical, chemical, biological, or electrical characteristics of the invention. The report should also include any request for foreign patent rights under subparagraph (c)(4) of this clause and any request to file a domestic patent application under subparagraph (d)(1) of this clause. However, such requests shall be made within the period set forth in subparagraph (b)(2) of this clause. When an invention is reported under this subparagraph (e)(2)(i), it shall be presumed to have been made in the manner specified in Section 9(a)(1) and (2) of 42 U.S.C. 5908 unless the Participant contends it was not so made in accordance with subparagraph (g)(2)(ii) of this clause.

(ii) Upon request, but not more than annually, interim reports on a DOE-approved form listing Subject Inventions and subcontracts awarded containing a Patent Rights clause for that period and certifying that:

(A) The Participant's procedures for identifying and disclosing Subject Inventions as required by this paragraph (e) have been followed throughout the reporting period;

(B) All Subject Inventions have been disclosed or that there are no such inventions; and

(C) All subcontracts containing a Patent Rights clause have been reported or that no such subcontracts have been awarded.

(iii) A final report on a DOE-approved form within three (3) months after completion of the agreement work listing all Subject Inventions and all subcontracts awarded containing a Patent Rights clause and certifying that:

(A) All Subject Inventions have been disclosed or that there were no such inventions; and

(B) All subcontracts containing a Patent Rights clause have been reported or that no such subcontracts have been awarded.

(3) The Participant shall obtain patent agreements to effectuate the provisions of this clause from all persons in its employ who perform any part of the work under this agreement except nontechnical personnel, such as clerical employees and manual laborers.

(4) The Participant agrees that the Government may duplicate and disclose Subject Invention disclosures and all other reports and papers furnished or required to be furnished pursuant to this clause. If the Participant is to file a foreign patent application on a Subject

21. PATENT RIGHTS - LONG FORM (Cont'd)

Invention, the Government agrees, upon written request, to use its best efforts to withhold publication of such invention disclosures until the expiration of the time period specified in subparagraph (d)(1) of this clause, but in no event shall the Government or its employees be liable for any publication thereof.

(f) Publication. It is recognized that during the course of the work under this agreement, the Participant or its employees may from time to time desire to release or publish information regarding scientific or technical developments conceived or first actually reduced to practice in the course of or under this agreement. In order that public disclosure of such information will not adversely affect the patent interests of DOE or the Participant, patent approval for release or publication shall be secured from Patent Counsel prior to any such release or publication.

(g) Forfeiture of Rights in Unreported Subject Inventions.

(1) The Participant shall forfeit to the Government, at the request of the Secretary or his designee, all rights in any Subject Invention which the Participant fails to report to Patent Counsel (with notification by Patent Counsel to the Contracting Officer) within six (6) months after the time the Participant:

(i) Files or causes to be filed a United States or foreign patent application thereon; or

(ii) Submits the final report required by subparagraph (e)(2)(iii) of this article, whichever is later.

(2) However, the Participant shall not forfeit rights in a Subject Invention if, within the time specified in (1)(i) or (1)(ii) of this paragraph (g), the Participant:

(i) Prepares a written decision based upon a review of the record that the invention was neither conceived nor first actually reduced to practice in the course of or under the agreement and delivers the same to Patent Counsel (with notification by Patent Counsel to the Contracting Officer); or

(ii) Contending that the invention is not a Subject Invention the Participant nevertheless discloses the invention and all facts pertinent to this contention to the Patent Counsel (with notification by Patent Counsel to the Contracting Officer); or

(iii) Establishes that the failure to disclose did not result from the Participant's fault or negligence.

21. PATENT RIGHTS - LONG FORM (Cont'd)

(3) Pending written assignment of the patent applications and patents on a Subject Invention determined by the Secretary or his designee to be forfeited (such determination to be a final decision under the "Disputes" clause of this agreement), the Participant shall be deemed to hold the invention and the patent applications and patents pertaining thereto in trust for the Government. The forfeiture provision of this paragraph (g) shall be in addition to and shall not supersede other rights and remedies which the Government may have with respect to Subject Inventions.

(h) Examination of Records Relating to Inventions.

(1) The Contracting Officer or his authorized representative, until the expiration of three (3) years after final payment under this Agreement, shall have the right to examine any books (including laboratory notebooks), records, documents, and other supporting data of the Participant which the Contracting Officer or his authorized representative reasonably deems pertinent to the discovery or identification of Subject Inventions or to determine compliance with the requirements of this clause.

(2) The Contracting Officer or his authorized representative shall have the right to examine all books (including laboratory notebooks), records and documents of the Participant relating to the conception of first actual reduction to practice of inventions in the same field of technology as the work under this agreement to determine whether any such inventions are Subject Inventions, if the Participant refuses or fails to:

(i) Establish the procedures of subparagraph (e)(1) of this clause; or

(ii) Maintain and follow such procedures; or

(iii) Correct or eliminate any material deficiency in the procedures within thirty (30) days after the Contracting Officer notifies the Participant of such a deficiency.

(i) Withholding of Payment (Not Applicable to Subcontracts).

(1) Any time before final payment of the amount of this agreement, the Contracting Officer may, if he deems such action warranted, withhold payment until a reserve not exceeding $50,000 or 5 percent of the amount of this agreement, whichever is less, shall have been set aside if in his opinion the Participant fails to:

(i) Establish, maintain and follow effective procedures for identifying and disclosing Subject Inventions pursuant to subparagraph (e)(1) of this clause; or

21. PATENT RIGHTS - LONG FORM (Cont'd)

(ii) Disclose any Subject Invention pursuant to subparagraph (e)(2)(i) of this clause; or

(iii) Deliver the interim reports pursuant to subparagraph (e)(2)(ii) of this clause; or

(iv) Provide the information regarding subcontracts pursuant to subparagraph (j)(5) of this clause; or

(v) Convey to the Government in a DOE-approved form the title and/or rights of the Government in each Subject Invention as required by this clause.

(2) The reserve or balance shall be withheld until the Contracting Officer has determined that the Participant has rectified whatever deficiencies exist and has delivered all reports, disclosures, and other information required by the clause.

(3) Final payment under this agreement shall not be made by the Contracting Officer before the Participant delivers to Patent Counsel all disclosures of Subject Inventions and other information required by subparagraph (e)(2)(i) of this clause, the final report required by subparagraph (e)(2)(iii) of this clause, and Patent Counsel has issued a patent clearance certification to the Contracting Officer.

(4) The Contracting Officer may, in his discretion, decrease or increase the sums withheld up to the maximum authorized above. If the Participant is a nonprofit organization, the maximum amount that may be withheld under this paragraph shall not exceed $50,000 or 1 percent of the amount of this agreement, whichever is less. No amount shall be withheld under this paragraph while the amount specified by this paragraph is being withheld under other provisions of the agreement. The withholding of any amount or subsequent payment thereof shall not be construed as a waiver of any rights accruing to the Government under this agreement.

(j) Subcontracts.

(1) For the purpose of this paragraph the term "Participant" means the party awarding a subcontract and the term "subcontractor" means the party being awarded a subcontract, regardless of tier.

(2) Unless otherwise authorized or directed by the Contracting Officer, the Participant shall include the Patent Rights clause of 41 CFR 9-9.107-5(a) or 41 CFR 9-9.107-6 as appropriate, modified to identify the parties in any subcontract hereunder having as a purpose the conduct of research, development, or demonstration work. In the event of refusal

21. PATENT RIGHTS - LONG FORM (Cont'd)

by a subcontractor to accept this clause, or if in the opinion of the Participant this clause is inconsistent with DOE's patent policies, the Participant:

(i) Shall promptly submit written notice to the Contracting Officer setting forth reasons for the subcontractor's refusal and other pertinent information which may expedite disposition of the matter; and

(ii) Shall not proceed with the subcontract without the written authorization of the Contracting Officer.

(3) Except as may be otherwise provided in this clause, the Participant shall not, in any subcontract or by using a subcontract as consideration therefor, acquire any rights in its subcontractor's Subject Invention for the Participant's own use (as distinguished from such rights as may be required solely to fulfill the Participant's agreement obligations to the Government in the performance of this agreement).

(4) All invention disclosures, reports, instruments, and other information required to be furnished by the subcontractor to DOE, under the provisions of a Patent Rights clause in any subcontract hereunder may, in the discretion of the Contracting Officer, be furnished to the Participant for transmission to DOE.

(5) The Participant shall promptly notify the Contracting Officer in writing upon the award of any subcontract containing a Patent Rights clause by identifying the subcontractor, the work to be performed under the subcontract, and the dates of award, and estimated completion. Upon the request of the Contracting Officer the Participant shall furnish him a copy of the subcontract.

(6) The Participant shall identify all Subject Inventions of the subcontractor of which it acquires knowledge in the performance of this Agreement and shall notify the Patent Counsel (with notification by Patent Counsel to the Contracting Officer) promptly upon the identification of the inventions.

(7) It is understood that the Government is a third party beneficiary of any subcontract clause granting rights to the Government in Subject Inventions, and the Participant hereby assigns to the Government all rights that the Participant would have to enforce the subcontractor's obligations for the benefit of the Government with respect to Subject Inventions. The Participant shall not be obligated to enforce the agreements of any subcontractor hereunder relating to the obligations of the subcontractor to the Government regarding Subject Inventions.

21. PATENT RIGHTS - LONG FORM (Cont'd)

(k) Background Patents.

(1) "Background Patent" means a domestic patent covering an invention or discovery which is not a Subject Invention and which is owned or controlled by the Participant at any time through the completion of this agreement:

(i) Which the Participant, but not the Government, has the right to license to others without obligation to pay royalties thereon; and

(ii) Infringement of which cannot reasonably be avoided upon the practice of any specific process, method, machine, manufacture or composition of matter (including relatively minor modifications thereof) which is a subject of the research, development, or demonstration work performed under this agreement.

(2) The Participant agrees to and does hereby grant to the Government a royalty-free, nonexclusive, license under any Background Patent for purposes of practicing a subject of this agreement by or for the Government in research, development, and demonstration work only.

(3) The Participant also agrees that upon written application by DOE, it will grant to responsible parties for purposes of practicing a subject of this agreement, nonexclusive licenses under any Background Patent on terms that are reasonable under the circumstances. If, however, the Participant believes that exclusive or partially exclusive rights are necessary to achieve expeditious commercial development or utilization, then a request may be made to DOE for DOE approval of such licensing by the Participant.

(l) Atomic Energy.

(1) No claim for pecuniary award or compensation under the provisions of the Atomic Energy Act of 1954, as amended, shall be asserted by the Participant or its employees with respect to any invention or discovery made or conceived in the course of or under this agreement.

(2) Except as otherwise authorized in writing by the Contracting Officer, the Participant will obtain patent agreements to effectuate the provisions of subparagraph (l)(1) of this clause from all persons who perform any part of the work under this agreement, except nontechnical personnel, such as clerical employees and manual laborers.

21. PATENT RIGHTS - LONG FORM (Cont'd)

(m) Limitation of Rights. Nothing contained in this Patent Rights clause shall be deemed to give the Government any rights with respect to any invention other than a Subject Invention except as set forth in the Patent Rights article of this Agreement with respect to Background Patents and the Facilities License.

22. FLOOD INSURANCE (10 CFR 600.12) (See under clauses 11., 12, and 13)

23. APPLICABILITY UTILIZATION OF LABOR SURPLUS AREA CONCERNS (FAR 52.220-3) (APR 1984)

(a) Applicability. This clause is applicable if this agreement exceeds the appropriate small purchase limitation in Part 13 of the Federal Acquisition Regulation.

(b) Policy. It is the policy of the Government to award contracts to concerns that agree to perform substantially in labor surplus areas (LSA's) when this can be done consistent with the efficient performance of the agreement and at prices no higher than are obtainable elsewhere. The Participant agrees to use its best efforts to place its subcontracts in accordance with this policy.

(c) Order of Preference. In complying with paragraph (b) above and with paragraph (c) of the clause of this agreement entitled Utilization of Small Business Concerns Owned and Small Disadvantaged Business Concerns, the Participant shall observe the following order of preference in awarding subcontracts: (1) small business concerns that are LSA concerns, (2) other small business concerns, and (3) other LSA concerns.

(d) Definitions. "Labor surplus area," as used in this clause, means a geographical area identified by the Department of Labor in accordance with 20 CFR 654, Subpart A, as an area of concentrated unemployment or underemployment or an area of labor surplus.

"Labor surplus area concern" as used in this clause means a concern that together with its first-tier subcontractors will perform substantially in labor surplus areas. Performance is substantially in labor surplus areas if the costs incurred under the contract on account of manufacturing, production, or performance of appropriate services in labor surplus areas exceed 50 percent of the contract price.

24. DISPUTES (10 CFR 600.26)

(a) Final determination. Whenever practicable, DOE shall attempt to resolve informally any dispute over the award or administration of financial assistance. At the initiative of DOE or upon the written request of an applicant for a continuation award or of a recipient, DOE shall mail (by

24. DISPUTES (10 CFR 600.26) (Cont'd)

certified mail) a brief written determination signed by a Contracting Officer, setting forth DOE's final dispositon of any dispute which is not resolved informally. Such determination shall contain the following information:

(1) A summary of the dispute, including a statement of the issues and of the positions taken by the Department and the party or parties to the dispute; and

(2) The factual, legal and policy reasons for DOE's disposition of the dispute.

(b) Right of appeal. Except as provided in paragraph (d)(1) of this secton, the final determination under paragraph (a) of this secton may be appealed to the Financial Assistance Appeals Board (the Board) in accordance with the procedures set forth in 10 CFR Part 1024. If the final determinatio under paragraph (a) of this sectio involves a dispute over which the Board has jurisdicion as provided in paragraph (d)(2) of this section, the Contracting Officer's determination shall state that, with respect to such dispute, the determination shall be the final decision of the Department unless, within 60 days, a written notice of appeal is filed. If the final determination under paragraph (a) of this section involves a dispute over which the Board has no jurisdiction as provided in paragraph (d)(1) of this section, the Contracting Officer's determination shall state that, effective immediately or on a later date specified therein, the determination shall, with respect to such dispute, be the final decision of the Department.

(c) Effect of appeal. The filing of an appeal with the Board shall not stay any determination or action taken by DOE which is the subject of the appeal. Consistent with its obligation to protect the interests of the Federal Government. DOE may take such authorized actions as may be necessary to preserve the status quo pending decision by the Board, or to preserve its ability to provide relief in the event the Board decides in favor of the appellant.

(d) Review on appeal.

(1) The Board shall have no jurisdiction to review:

(i) Any preaward dispute (except as provided in paragraph (d)(2)(ii) of this section), including use of any special restrictive condition pursuant to § 600.105;

(ii) DOE denial of a request for a deviation under § 600.4 of this part;

(iii) DOE denial of a request for a budget revision or other change in the approved project under §§ 600.103, 600.114 or 600.271 of this part or under another term or condition of the award;

24. DISPUTES (Cont'd)

(iv) Any DOE action authorized under §§ 600.121(b)(1), (2), (3) or (5) or 600.271 of this part with respect to recipient noncompliance, or such actions authorized by program rule;

(v) Any DOE decision about an action requiring prior DOE approval, under §§ 600.112(g), 600.119, or 600.271 of this part or under another term or condition of the award:

(vi) A DOE decision not to make a continuation award, which decision is based on the insufficiency of available appropriations;

(vii) Any matter which is under the jurisdicition of the Patent Compensation Board (10 CFR 780.3);

(vii) Any matter which may be heard by the Invention Licensing Appeals Board (10 CFR 781.65 and 781.66); or

(ix) Any other dispute not described in paragraph (d)(2) of this section.

(2) In addition to any right of appeal established by program rule, or by the terms and conditions (not inconsistent with paragraph (d)(1) of this secion) of an award, the Board shall have jurisdicton to review:

(i) A DOE determination that the recipient has failed to comply with the applicable requirements of this part, the program statute or rules, or other terms and conditons of the award;

(ii) A DOE decision not to make a continuation award based on any of the determinations describe in paragraph (d)(2)(i) of this section;

(iii) Termination of an award for cause, in whole or in part, by DOE;

(iv) A DOE determination that an award is void or invalid;

(v) The application by DOE of an indirect cost rate; and

(vi) DOE disallowance of costs.

(3) In reviewing disputes authorized under paragraph (d)(2) of this section, the Board shall be bound by the applicable law, statutes, and rules, including the requirements of this part, and by the terms and conditions of the award.

(4) The decision of the Board shall be the final decision of the Department.

25. SUBCONTRACTS UNDER COST REIMBURSEMENT AND LETTER AGREEMENTS (FAR 52.244-2) (APR 1984)

(a) "Subcontract," as used in this clause, includes but is not limited to purchase orders, and changes and modifications to purchase orders. The Participant shall notify the Contracting Officer reasonably in advance of entering into any subcontract if -

(1) The proposed subcontract is of the cost-reimbursement, time-and-materials, or labor-hour type;

(2) The proposed subcontract is fixed-price and exceeds either $25,000 or 5 percent of the total estimated cost of this agreement;

(3) The proposed subcontract has experimental, developmental, or research work as one of its purposes; or

(4) This agreement is not a facilities contract and the proposed subcontract provides for the fabrication, purchase, rental, installation, or other acquisition of special test equipment valued in excess of $10,000 or of any items of industrial facilities.

(b)(1) In the case of a proposed subcontract that (i) is of the cost-reimbursement, time-and-materials, or labor-hour type and is estimated to exceed $10,000, including any fee, (ii) is proposed to exceed $100,000, (iii) is one of a number of subcontracts with a single subcontractor, under this agreement for the same or related supplies or services that, in the aggregate, are expected to exceed $100,000, the advance notification required by paragraph (a) above shall include the information specified in subparagraph (2) below.

(2)(i) A description of the supplies or services to be subcontracted.

(ii) Identification of the type of subcontract to be used.

(iii) Identification of the proposed subcontractor and an explanation of why and how the proposed subcontractor was selected, including the competition obtained.

(iv) The proposed subcontract price and the Participant's cost or price anlaysis.

(v) The subcontractor's current, complete, and accurate cost or pricing data and Certificate of Current Cost or Pricing Data, if required by other agreement provisions.

(vi) The subcontractor's Disclosure Statement or Certificate relating to Cost Accounting Standards when such data are required by other provisions of this agreement.

(vii) A negotiation memorandum reflecting

25. SUBCONTRACTS UNDER COST REIMBURSEMENT AND LETTER AGREEMENTS (FAR 52.244-2) (APR 1984) (Cont'd)

(A) The principal elements of the subcontract price negotiations;

(B) The most significant considerations controlling establishment of initial or revised prices;

(C) The reason cost or pricing data were or were not required;

(D) The extent, if any, to which the Participant did not rely on the subcontractor's cost or pricing data in determining the price objective and in negotiating the final price;

(E) The extent to which it was recognized in the negotiation that the subcontractor's cost or pricing data were not accurate, complete, or current; the action taken by the Participant and the subcontractor; and the effect of any such defective data on the total price negotiated;

(F) The reasons for any significant difference between the Participant's price objective and the price negotiated; and

(G) A complete explanation of the incentive fee or profit plan when incentives are used. The explanation shall identify each critical performance element, management decisions used to quantify each incentive element, reasons for the incentives, and a summary of all trade-off possibilities considered.

(c) The Participant shall obtain the Contracting Officer's written consent before placing any subcontract for which advance notification is required under paragraph (a) above. However, the Contracting Officer may ratify in writing any such subcontract. Ratification shall constitute the consent of the Contracting Officer.

(d) If the Participant has an approved purchasing system and the subcontract is within the scope of such approval, the Participant may enter into the subcontracts described in subparagraphs (a)(1) and (a)(2) above without the consent of the Contracting Officer, unless this agreement is for the acquisition of major systems, subsystems, or their components.

(e) Even if the Participant's purchasing system has been approved, the Participant shall obtain the Contracting Officer's written consent before placing subcontracts that have been selected for special surveillance and identified in the Schedule of this agreement.

(f) Unless the consent or approval specifically provides otherwise, neither consent by the Contracting Officer to any subcontract nor approval of the Participant's purchasing system shall constitute a determination (1) of

25. SUBCONTRACTS UNDER COST REIMBURSEMENT AND LETTER AGREEMENTS (FAR 52.244-2) (APR 1984) (Cont'd)

the acceptability of any subcontract terms or conditions (2) of the allowability of any cost under this agreement or (3) to relieve the Participant of any responsibility for performing this agreement.

(g) No subcontract placed under this agreement shall provide for payment on a cost-plus-a-percentage-of-cost basis, and any fee payable under cost-reimbursement type subcontracts shall not exceed the fee limitations in subsection 16.301-4 of the Federal Acquisition Regulation (FAR).

(h) The Participant shall give the Contracting Officer immediate written notice of any action or suit filed and prompt notice of any claim made against the Participant by any subcontractor or vendor that, in the opinion of the Participant may result in litigation related in any way to this agreement, with respect to which the Participant may be entitiled to reimbursement from the Government.

(i)(1) The Participant shall insert in each price redetermination or incentive price revision subcontract under this agreement the substance of the paragraph "Quarterly limitation on payments statement" of the clause at 52.216-5, Price Redetermination Prospective, 52.216-6, Price Redetermination Retroactive, 52.216-16, Incentive Price Revision-Firm Target, or 52.216-17 Incentive Price Revision-Successive Targets, as appropriate, modified in accordance with the paragraph entitled "Subcontracts" of that clause.

(2) Additionally, the Participant shall include in each cost-reimbursement subcontract under this agreement a requirement that the subcontractor insert the substance of the appropriate modified subparagraph referred to in subparagraph (1) above in each lower tier price redetermination or incentive price revision subcontract under that subcontract.

(j) To facilitate small business participation in subcontracting, the Participant agrees to provide progress payments on subcontracts under this agreement that are fixed-price subcontracts with small business concerns in conformity with the standards for customary progress payments stated in FAR 32.502-1 and 32.504(f), as in effect on the date of this agreement. The Participant further agrees that the need for such progress payments will not be considered a handicap or adverse factor in the award of subcontracts.

(k) The Government reserves the right to review the Participant's purchasing system as set forth in FAR Subpart 44.3.

26. TERMINATION - COST REIMBURSEMENT (FAR 52.249-6) (APR 1984)

NOTE: This clause applies to this contract unless the contractor is an educational or nonprofit institution, and the contract makes no provision for the payment of a profit or fee.

26. TERMINATION - COST REIMBURSEMENT (FAR 52.249-6) (APR 1984) (Cont'd)

(a) The Government may terminate performance of work under this agreement in whole or, from time to time, in part, if-

(1) The Contracting Officer determines that a termination is in the Government's interest; or

(2) The Participant defaults in performing this contract and fails to cure the default within 10 days (unless extended by the Conracting Officer) after receiving a notice specifying the default. "Default" includes failure to make progress in the work so as to endanger performance.

(b) The Contracting Officer shall terminate by delivering to the Participant a Notice of Termination specifying whether termination is for default of the Participant or for convenience of the Government, the extent of termination, and the effective date. If, after termination for default, it is determined that the Participant was not in default or that Participant failure to perform or to make progress in performance is due to causes beyond the control and without the fault or negligence of the Participant as set forth in the Excusable Delays clause, the rights and obligations of the parties will be the same as if the termination was for the convenience of the Government.

(c) After receipt of a Notice of Termination, and except as directed by the Contracting Officer, the Participant shall immediately proceed with the following obligations, regardless of any delay in determining or adjusting any amounts due under this clause:

(1) Stop work as specified in the notice.

(2) Place no further subcontracts or orders (referred to as subcontracts in this clause), except as necessary to complete the continued portion of the contract.

(3) Terminate all subcontracts to the extent they relate to the work terminated.

(4) Assign to the Government, as directed by the Contracting Officer, all right, title, and interest of the Participant under the subcontracts terminated, in which case the Government shall have the right to settle or to pay any termination settlement proposal arising out of those terminations.

(5) With approval or ratification to the extent required by the Contracting Officer, settle all outstanding liabilities and termination settlement proposals arising from the termination of subcontracts, the cost of which would be reimbursable in whole or in part, under this agreement; approval or ratification will be final for purposes of this clause.

26. TERMINATION - COST REIMBURSEMENT (FAR 52.249-6) (APR 1984) (Cont'd)

(6) Transfer title (if not already transferred) and, as directed by the Contracting Officer, deliver to the Government (i) the fabricated or unfabricated parts, work in process, completed work, supplies, and other material produced or acquired for the work terminated, (ii) the completed or partially completed plans, drawings, information, and other property that, if the agreement had been completed, would be required to be furnished to the Government, and (iii) the jigs, dies, fixtures, and other special tools and tooling acquired or manufactured for this agreement, the cost of which the Participant has been or will be reimbursed under this agreement.

(7) Complete performance of the work not terminated.

(8) Take any action that may be necessary, or that the Contracting Officer may direct, for the protection and preservation of the property related to this agreement that is in the possession of the Participant and in which the Government has or may acquire an interest.

(9) Use its best efforts to sell, as directed or authorized by the Contracting Officer, any property of the types referred to in subparagraph (6) above; provided, however, that the Participant (i) is not required to extend credit to any purchaser and (ii) may acquire the property under the conditions prescribed by, and at prices approved by, the Contracting Officer. The proceeds of any transfer or disposition will be applied to reduce any payments to be made by the Government under this agreement, credited to the price or cost of the work, or paid in any other manner directed by the Contracting Officer.

(d) After expiration of the plant clearance period as defined in Subpart 45.6 of the Federal Acquisition Regulation, the Participant may submit to the Contracting Officer a list, certified as to quantity and quality, of termination inventory not previously disposed of, excluding items authorized for disposition by the Contracting Officer. The Participant may request the Government to remove those items or enter into an agreement for their storage. Within 15 days, the Government will accept the items and remove them or enter into a storage agreement. The Contracting Officer may verify the list upon removal of the items, or if stored, within 45 days from submission of the list, and shall correct the list, as necessary, before final settlement.

(e) After termination, the Participant shall submit a final termination settlement proposal to the Contracting Officer in the form and with the certification prescribed by the Contracting Officer. The Participant shall submit the proposal promptly, but no later than 1 year from the effective date of termination, unless extended in writing by the Contracting Officer upon written request of the Participant within this 1-year period. However, if the Contracting Officer determines that the fact justify it, a termination settlement proposal may be received and acted on after 1 year or any extension. If the Participant fails to submit the proposal within the time

26. TERMINATION - COST REIMBURSEMENT (FAR 52.249-6) (APR 1984) (Cont'd)

allowed, the Contracting Officer may determine, on the basis of information available, the amount, if any, due the Participant because of the termination and shall pay the amount determined.

(f) Subject to paragraph (e) above, the Participant and the Contracting Officer may agree on the whole or any part of the amount to be paid (including an allowance for fee) because of the termination. The agreement shall be amended, and the Participant paid the agreed amount.

(g) If the Participant and the Contracting Officer fail to agree in whole or in part on the amount of costs and/or fee to be paid because of the termination of work, the Contracting Officer shall determine, on the basis of information available, the amount, if any, due the Participant, and shall pay that amount, which shall include the following:

(1) All costs reimbursable under this agreement, not previously paid, for the performance of this agreement before the effective date of the termination, and part of those costs that may continue for a reasonable time with the approval of or as directed by the Contracting Officer; however, the Participant shall discontinue those costs as rapidly as practicable.

(2) The cost of settling and paying termination settlement proposals under terminated subcontracts that are properly chargeable to the terminated portion of the agreement if not included in subparagraph (1) above.

(3) The reasonable cost of settlement of the work terminated, including -

(i) Accounting, legal, clerical, and other expenses reasonably necessary for the preparation of termination settlement proposals and supporting data;

(ii) The termination and settlement of subcontracts (excluding the amounts of such settlements); and

(iii) Storage, transportation, and other costs incurred, reasonably necessary for the preservation, protection, or disposition of the termination inventory. If the termination is for default, no amounts for the preparation of the Participant's termination settlement proposal may be included.

(4) A portion of the fee payable under the agreement, determined as follows:

(i) If the agreement is terminated for the convenience of the Government, the settlement shall include a percentage of the fee equal to the percentage of completion of work contemplated under the agreement, but excluding subcontract effort included in subcontractors' termination proposals, less previous payments for fee.

26. TERMINATION - COST REIMBURSEMENT (FAR 52.249-6) (APR 1984) (Cont'd)

(ii) If the agreement is terminated for default, the total fee payable shall be such proportionate part of the fee as the total number of articles (or amount of services) delivered to and accepted by the Government is to the total number of articles (or amount of services) of a like kind required by the agreement.

(5) If the settlement includes only fee, it will be determined under subparagraph (g)(4) above.

(h) The cost principles and procedures in Part 31 of the Federal Acquisition Regulation, in effect on the date of this contract, shall govern all cost claimed, agreed to, or determined under this clause.

(i) The Participant shall have the right of appeal, under the Disputes clause, from any determination made by the Contracting Officer under paragraph (e) or (g) above or paragraph (k) below, except that if the Participant failed to submit the termination settlement proposal within the time provided in paragraph (e) and failed to request a time extension, there is no right of appeal. If the Contracting Officer has made a determination of the amount due under paragraph (e), (g) or (k), the Government shall pay the Participant (1) the amount determined by the Contracting Officer if there is no right of appeal or if no timely appeal has been taken, or (2) the amount finally determined on an appeal.

(j) In arriving at the amount due the Participant under this clause, there shall be deducted-

(1) All unliquidated advance or other payments to the Participant, under the terminated portion of this agreement;

(2) Any claim which the Government has against the Participant under this agreement; and

(3) The agreed price for, or the proceeds of sale of materials, supplies, or other things acquired by the Participant or sold under this clause and not recovered by or credited to the Government.

(k) The Participant and Contracting Officer must agree to any equitable adjustment in fee for the continued portion of the agreement when there is a partial termination. The Contracting Officer shall amend the Cooperative Agreement to reflect the agreement.

(l)(1) The Government may, under the terms and conditions it prescribes, make partial payments and payments against costs incurred by the Participant for the terminated portion of the agreement, if the Contracting Officer believes the total of these payments will not exceed the amount to which the Participant will be entitled.

26. TERMINATION - COST REIMBURSEMENT (FAR 52.249-6) (APR 1984) (Cont'd)

(2) If the total payments exceed the amount finally determined to be due, the Participant shall repay the excess to the Government upon demand, together with interest computed at the rate established by the Secretary of the Treasury under 50 U.S.C App. 1215(b)(2). Interest shall be computed for the period from the date the excess payment is received by the Participant to the date the excess is repaid. Interest shall not be charged on any excess payment due to a reduction in the Participant's termination settlement proposal because of the retention or disposition, or a later date determined by the Contracting Officer because of the circumstances.

(m) The provisions of this clause relating to fee are inapplicable if this agreement does not include a fee.

27. PATENT INDEMNITY (41 CFR9-9.103-3(b)) (JUN 1979)

The Participant shall indemnify the Government and its officers, agents, and employees against liability, including costs, for infringement of U.S. Letter Patent (except U.S. Letters Patent issued upon an application which is now or may hereafter be kept secret or otherwise withheld from issue by order of the Government) resulting from the Participant's: (a) furnishing or supplying standard parts or components which have been sold or offered for sale to the public on the commercial open market; or (b) utilizing its normal practices or methods which normally are or have been used in providing goods and services in the commercial open market, in the performance of the Agreement; or (c) utilizing any parts, components, practices, or methods to the extent to which the Participant has secured indemnification from liability. The foregoing indemnity shall not apply unless the Participant shall have been informed as soon as practicable by the Government of the suit or action alleging such infringement, and shall have been given such opportunity as is afforded by applicable laws, rules, or regulations to participate in the defense thereof; and further, such indemnity shall not apply to a claimed infringement which is settled without the consent of the Participant, unless required by final decree of a court of competent jurisdiction or to an infringement resulting from addition to or change in such supplies or components furnished or construction work performed for which addition or change was made subsequent to delivery or performance by the Participant.

28. LIMITATION OF COST (FAR 52.232-20) (APR 1984)

NOTE: This clause applies to this agreement if it is a fully-funded agreement.

(a) The parties estimate that performance of this agreement, exclusive of any fee, will not cost the Government more than (1) the estimated cost specified in the Schedule or, (2) if this is a cost-sharing agreement, the Government's share of the estimated cost specified in the Schedule. The Participant agrees to use its best efforts to perform the work specified in

28. LIMITATION OF COST (FAR 52.232-20) (APR 1984) (Cont'd)

the Schedule and all obligations under this agreement within the estimated cost, which, if this is a cost-sharing agreement, includes both the Government's and the Participant's share of the cost.

(b) The Participant shall notify the Contracting Officer in writing whenever it has reason to believe that-

(1) The costs the Participant expects to incur under this agreement in the next 60 days, when added to all costs previously incurred, will exceed 75 percent of the estimated cost specified in the Schedule; or

(2) The total cost for the performance of this agreement, exclusive of any fee, will be either greater or substantially less than had been previously estimated.

(c) As part of the notification, the Participant shall provide the Contracting Officer a revised estimate of the total cost of performing this agreement.

(d) Except as required by other provisions of this agreement, specifically citing and stated to be an exception of this clause-

(1) The Government is not obligated to reimburse the Participant for costs incurred in excess of (i) the estimated cost specified in the Schedule or, (ii) if this is a cost-sharing agreement, the estimated cost to the Government specified in the Schedule; and

(2) The Participant is not obligated to continue performance under this agreement (including actions under the Termination clause of this agreement) or otherwise incur costs in excess of the estimated cost specified in the Schedule, until the Contracting Officer (i) notifies the Participant in writing that the estimated cost has been increased and (ii) provides a revised estimated total cost of performing this agreement. If this is a cost-sharing agreement, the increase shall be allocated in accordance with the formula specified in the Schedule.

(e) No notice, communication, or representation in any form other than that specified in subparagraph (d)(2) above, or from any person other than the Contracting Officer, shall affect this agreement's estimated cost to the Government. In the absence of the specified notice, the Government is not obligated to reimburse the Participant for any costs in excess of the estimated cost or, if this is a cost-sharing agreement, for any costs in excess of the estimated cost to the Government specified in the Schedule, whether those excess costs were incurred during the course of the agreement or as a result of termination.

28. LIMITATION OF COST (FAR 52.232-20) (APR 1984) (Cont'd)

(f) If the estimated cost specified in the Schedule is increased, any costs the Participant incurs before the increase that are in excess of the previously estimated cost shall be allowable to the same extent as if incurred afterward, unless the Contracting Officer issues a termination or other notice directing that the increase is solely to cover termination or other specified expenses.

(g) Change orders shall not be considered an authorization to exceed the estimated cost to the Government specified in the Schedule, unless they contain a statement increasing the estimated cost.

(h) If this agreement is terminated or the estimated cost is not increased, the Government and the Participant shall negotiate an equitable distribution of all property produced or purchased under the agreement, based upon the share of costs incurred by each.

29. ALLOWABLE COST AND PAYMENT (DEAR 952.216-7) (APR 1984)

(a) Invoicing. The Government shall make payments to the Participant when requested as work progresses, but (except for small business concerns) not more often than once a month, in amounts determined to be allowable by the Contracting Officer in accordance with the applicable cost principles of the Federal Acquisition Regulation (FAR) and the DOE Acquisition Regulation (DEAR) in effect on the date of this agreement and their terms of this agreement. The applicable cost principles are:

(i) FAR Subpart 31.2 and DEAR Subpart 931.2, if the Participant is a commercial organization;

(ii) OMB Circular A-21, if the Participant is an educational institution;

(iii) OMB Circular A-87, if the Participant is a state or local government or Federally recognized Indian tribal government; or

(iv) OMB Circular A-122, if the Participant is a nonprofit organization.

(1) The Participant may submit to an authorized representative of the Contracting Officer, in such form and reasonable detail as the representative may require, an invoice or voucher supported by a statement of the claimed allowable cost for performing this agreement.

(b) Reimbursing costs. (1) For the purpose of reimbursing allowable costs (except as provided in subparagraph (2) below, with respect to pension, deferred profit sharing, and employee stock ownership plan contributions) the term "costs" includes only:

29. ALLOWABLE COST AND PAYMENT (DEAR 952.216-7) (APR 1984) (Cont'd)

(i) Those recorded costs that, at the time of the request for reimbursement, the Participant has paid by cash, check, or other form of actual payment for items or services purchased directly for the agreement;

(ii) When the Participant is not delinquent in paying costs of agreement performance in the ordinary course of business, costs incurred, but not necessarily paid, for-

(A) Materials issued from the Participant's inventory and placed in the production process for use on the agreement;

(B) Direct labor;

(C) Direct travel;

(D) Other direct in-house costs; and

(E) Properly allocable and allowable indirect costs, as shown in the records maintained by the Participant for purposes of obtaining reimbursement under Government agreements; and

(iii) The amount of progress payments that have been paid to the Participant's subcontractors under similar cost standards.

(2) Participant contributions to any pension, profit-sharing, or employee stock ownership plan funds that are paid quarterly or more often may be included in indirect costs for payment purposes; provided, that the Participant pays the contribution to the fund within 30 days after the close of the period covered. Payments made 30 days or more after the close of a period shall not be included until the Participant actually makes the payment. Accrued costs for such contributions that are paid less often than quarterly shall be excluded from indirect costs for payment purposes until the Participant actually makes the payment.

(3) Notwithstanding the audit and adjustment of invoices or vouchers under paragraph (g) below, allowable indirect costs under this agreement shall be obtained by applying indirect cost rates established in accordance with paragraph (d) below.

(4) Any statements in specifications or other documents incorporated in this agreement by reference designating performance of services or furnishing of materials at the Participant's expense or at no cost to the Government shall be disregarded for purposes of cost-reimbursement under this clause.

29. ALLOWABLE COST AND PAYMENT (DEAR 952.216-7) (APR 1984) (Cont'd)

(c) Small business concern. A small business concern may be paid more often than every 2 weeks and may invoice and be paid for recorded costs for items or services purchased directly for the agreement, even though the concern has not yet paid for those items or services.

(d) Final indirect cost rates. (1) Final annual indirect cost rates and the appropriate bases shall be established in accordance with Subpart 42.7 of the Federal Acquisition Regulation (FAR) in effect for the period covered by the indirect cost rate proposal.

(2) The Participant shall, within 90 days after the expiration of each of its fiscal years, or by a later date approved by the Contracting Officer, submit to the cognizant Contracting Officer responsible for negotiating its final indirect cost rates and, if required by agency procedures, to the cognizant audit activity proposed final indirect cost rates for that period and supporting cost data specifying the agreement and/or subagreement to which the rates apply. The proposed rates shall be based on the Participant's actual cost experience for that period. The appropriate Government representative and Participant shall establish the final indirect cost rates as promptly as practical after receipt of the Participant's proposal.

(3) The Participant and the appropriate Government representative shall execute a written understanding setting forth the final indirect cost rates. The understanding shall specify (i) the agreed-upon final annual indirect cost rates, (ii) the bases to which the rates apply, (iii) the periods for which the rates apply, (iv) any specific indirect cost items treated as direct costs in the settlement, and (v) the affected agreement and/or subagreement, identifying any with advance agreements or special terms and the applicable rates. The understanding shall not change any monetary ceiling, agreement obligation, or specific cost allowable or disallowance provided for in this agreement. The understanding is incorporated into this agreement upon execution.

(4) Failure by the parties to agree on a final annual indirect cost rate shall be a dispute within the meaning of the Disputes clause.

(e) Billing rates. Until final annual indirect cost rates are established for any period, the Government shall reimburse the Participant at billing rates established by the Contracting Officer or by an authorized representative (the cognizant auditor), subject to adjustment when the final rates are established. These billing rates-

(1) Shall be the anticipated final rates; and

(2) May be prospectively or retroactively revised by mutual agreement, at either party's request, to prevent substantial overpayment or underpayment.

29. ALLOWABLE COST AND PAYMENT (DEAR 952.216-7) (APR 1984) (Cont'd)

(f) Quick-closeout procedures. When the Participant and Contracting Officer agree, the quick-closeout procedures of Subpart 42.7 of the FAR may be used.

(g) Audit. At any time or times before final payment, the Contracting Officer may have the Participant's invoices or vouchers and statements of cost audited. Any payment may be (1) reduced by amounts found by the Contracting Officer not to constitute allowable costs or (2) adjusted for prior overpayments or underpayments.

(h) Final payment. (1) The Participant shall submit a completion invoice or voucher, designated as such, promptly upon completion of the work, but no later than one year (or longer, as the Contracting Officer may approve in writing) from the completion date. Upon approval of that invoice or voucher, and upon the Participant's compliance with all terms of this agreement, the Government shall promptly pay any balance of allowable costs and that part of the fee (if any) not previously paid.

(2) The Participant shall pay to the Government any refunds, rebates, credits, or other amounts (including interest, if any) accruing to or received by the Participant or any assignee under this agreement, to the extent that those amounts are properly allocable to costs for which the Participant has been reimbursed by the Government. Reasonable expenses incurred by the Participant for securing refunds, rebates, credits, or other amounts shall be allowable costs if approved by the Contracting Officer. Before final payment under this agreement, the Participant and each assignee whose assignment is in effect at the time of final payment shall execute and deliver-

(i) An assignment to the government, in form and substance satisfactory to the Contracting Officer, of refunds, rebates, credits, or other amounts (including interest, if any) properly allocable to costs for which the Participant has been reimbursed by the Government under this agreement; and

(ii) A release discharging the Government, its officers, agents, and employees from all liabilities, obligations, and claims arising out of or under this agreement, except-

(A) Specified claims stated in exact amount, or in estimated amounts when the exact amounts are not known;

(B) Claims (including reasonable incidental expenses) based upon liabilities of the Participant to third parties arising out of the performance of this agreement; provided, that the claims are not known to the Participant on the date of the execution of the release, and that the Participant gives notice of the claims in writing to the Contracting Officer within 6 years following the release date or notice of final payment date, whichever is earlier; and

29. ALLOWABLE COST AND PAYMENT (DEAR 952.216-7) (APR 1984) (Cont'd)

(C) Claims for reimbursement of costs, including reasonable incidental expenses, incurred by the Participant under the patent clauses of this agreement, excluding, however, any expenses arising from the Participant's indemnification of the Government against patent liability.

30. BUY AMERICAN ACT (FAR 52.225-5)(APR 1984)

(a) The Buy American Act (41 U.S.C. 10) provides that the Government give preference to domestic construction material.

"Components," as used in this clause, means those articles, materials, and supplies incorporated directly into construction materials.

"Construction materials," as used in this clause, means articles, materials, and supplies brought to the construction site for incorporation into the building or work.

"Domestic construction material" as used in this clause, means (1) an unmanufactured construction material mined or produced in the United States, or (2) a construction material manufactured in the United States, if the cost of its components mined, produced, or manufactured in the United States exceeds 50 percent of the cost of all its components. Components of foreign origin of the same class or kind as the construction materials determined to be unavailable pursuant to subparagraph 25.202(a)(3) of the Federal Acquisition Regulation (FAR) shall be treated as domestic.

(b) The Participant agrees that only domestic construction material will be used by the Participant, subcontractors, materialmen, and suppliers in the performance of this agreement except for foreign construction materials, if any listed in this agreement.

(The foregoing requirements are administered in accordance with Executive Order No. 10582, dated December 17, 1954, as amended, and Subpart 25.2 of the FAR).

31. ADDITIONAL TECHNICAL DATA REQUIREMENTS (DEAR 952.227-73)(APR 1984)

(a) In addition to the technical data specified elsewhere in this agreement to be delivered, the Contracting Officer may at any time during the agreement performance or within one year after final payment call for the Participant to deliver any technical data first produced or specifically used in the performance of this agreement except technical data pertaining to items of standard commercial design.

31. ADDITIONAL TECHNICAL DATA REQUIREMENTS (DEAR 952.227-73)(APR 1984) (Cont'd)

(b) The provisions of the "Rights in Technical Data" clause included in this agreement are applicable to all technical data called for under this Additional Technical Data Requirements clause. Accordingly, nothing contained in this clause shall require the Participant to actually deliver any technical data, the delivery of which is excused by paragraph (e) of the "Rights in Technical Data" clause.

(c) When technical data are to be delivered under this clause, the Participant will be compensated for appropriate costs for converting such data into the prescribed form, for reproduction, and for delivery.

32. UTILIZATION OF SMALL BUSINESS CONCERNS AND SMALL DISADVANTAGED BUSINESS CONCERNS (FAR 52.219-8)(APR 1984)

(a) It is the policy of the United States that small business concerns and small business concerns owned and controlled by socially and economically disadvantaged individuals shall have the maximum practicable opportunity to participate in performing agreements let by any Federal agency.

(b) The Participant hereby agrees to carry out this policy in the awarding of subcontracts to the fullest extent consistent with efficient agreement performance. The Participant further agrees to cooperate in any studies or surveys as may be conducted by the United States Small Business Administration or the awarding agency of the United States as may be necessary to determine the extent of the Participant's compliance with this clause.

(c) As used in this agreement, the term "small business concern" shall mean a small business as defined pursuant to Section 3 of the Small Business Act and relevant regulations promulgated pursuant thereto.

The term "small business concern owned and controlled by socially and economically disadvantaged individuals" shall mean a small business concern -

(1) Which is at least 51 per centum owned by one or more socially and economically disadvantaged individuals; or, in the case of any publicly-owned business, at least 51 per centum of the stock of which is owned by one or more socially and economcically disadvantaged individuals; and

(2) Whose management and daily business operations are controlled by one or more of such individuals.

The Participant shall presume that socially and economically disadvantaged individuals include Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Asian-Indian Americans, and other minorities, or any other individual found to be disadvantaged by the Administration pursuant to Section 8(a) of the Small Business Act.

32. UTILIZATION OF SMALL BUSINESS CONCERNS AND SMALL DISADVANTAGED BUSINESS CONCERNS (FAR 52.219-8)(APR 1984) (Cont'd)

(d) Participants acting in good faith may rely on written representations by their subcontractors regarding their status as either a small business concern or a small business concern owned and controlled by socially and economically disadvantaged individuals.

33. UTILIZATION OF WOMEN-OWNED SMALL BUSINESSES (FAR 52.219-13)(APR 1984)

(a) "Women-owned small businesses," as used in this clause, means businesses that are at least 51 percent owned by women who are United States citizens and who also control and operate the business.

"Control," as used in this clause, means exercising the power to make policy decisions.

"Operate," as used in this clause, means being actively involved in the day-to-day management of the business.

(b) It is the policy of the United States that women-owned small businesses shall have the maximum practicable opportunity to participate in performing agreements awarded by any Federal agency.

(c) The Participant agrees to use its best efforts to give women-owned small businesses the maximum practicable opportunity to participate in the subcontracts it awards to the fullest extent consistent with the efficient performance of its agreement.

34. LABOR STANDARDS FOR FEDERAL SERVICE AGREEMENTS

The clauses set forth in the following paragraphs shall be included in full by the contracting agency in every contract entered into by the United States or the District of Columbia, in excess of $2,500, or in an indefinite amount, the principal purpose of which is to furnish services through the use of service employees:

(a) Service Contract Act of 1965, as amended: This agreement is subject to the Service Contract Act of 1965, as amended (41U.S.C. 351 et seq.) and is subject to the following provisions and to all other applicable provisions of the Act and regulations of the Secretary of Labor issued thereunder (29 CFR Part 4).

(b)(1) Each service employee employed in the performance of this agreement by the Participant or any subcontractor shall be paid not less than the minimum monetary wages and shall be furnished fringe benefits in accordance with the wages and fringe benefits determined by the Secretary of Labor or authorized representative, as specified in any wage determination attached to this agreement.

34. LABOR STANDARDS FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

(2)(i) If there is such a wage determination attached to this agreement, the Contracting Officer shall require that any class of service employee which is not listed therein and which is to be employed under the agreement (i.e., the work to be performed is not performed by any classification listed in the wage determination), be classified by the Participant so as to provide a reasonable relationship (i.e., appropriate level of skill comparison) between such unlisted classifications and the classifications listed in the wage determination. Such conformed class of employees shall be paid the monetary wages and furnished the fringe benefits as are determined pursuant to the procedures in this section. (The information collection requirements contained in the following paragraphs of this section have been approved by the Office of Management and Budget under OMB control number 1215-0150.)

(ii) Such conforming procedure shall be initiated by the Participant prior to the performance of agreement work by such unlisted class of employee. A written report of the proposed conforming action, including information regarding the agreement or disagreement of the authorized representative of the employees involved or, where there is no authorized representative, the employees themselves, shall be submitted by the Participant to the contracting officer no later than 30 days after such unlisted class of employees performs any agreement work. The Contracting Officer shall review the proposed action and promptly submit a report of the action, toegther with the agency's recommendations and all pertinent information including the position of the contractor and the employees, to the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, for review. The Wage and Hour Division will approve, modify, or disapprove the action or render a final determination in the event of disagreement within 30 days of receipt or will notify the Contracting Officer within 30 days of receipt that additional time is necessary.

(iii) The final determination of the conformance action by the Wage and Hour Division shall be transmitted to the Contracting Officer who shall promptly notify the Participant of the action taken. Each affected employee shall be furnished by the Participant with a written copy of such determination or it shall be posted as a part of the wage determination.

(iv)(A) The process of establishing wage and fringe benefit rates that bear a reasonable relationship to those listed in a wage determination cannot be reduced to any single formula. The approach used may vary from wage determination to wage determination depending on the circumstances. Standard wage and salary administration practices which rank various job classifications by pay grade pursuant to point point schemes or other job factors may, for example, be relied upon. Guidance may also be obtained from the way different jobs are rated under Federal pay systems (Federal Wage Board Pay System and the General Schedule) or from other wage determinations issued in the same locality. Basic to the establishment of any conformable wage rate(s) is the concept that a pay relationship should be maintained between job classifications based on the skill required and the dutues performed.

34. LABOR STANDARDS FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

(B) In the case of an agreement modification, an exercise of an option or extension of an existing agreement, or in any other case where a Participant succeeds an agreement under which the classification in question was previously conformed pursuant to this section, a new conformed wage rate and fringe benefits may be assigned to such conformed classification by indexing (i.e., adjusting) the previous conformed rate and fringe benefits by an amount equal to the average (mean) percentage increase (or decrease, where appropriate) between the wages and fringe benefits specified for all classifications to be used on the agreement which are listed in the current wage determination, and those specified for the corresponding classifications in the previously applicable wage determination. Where conforming actions are accomplished in accordance with this paragraph prior to the performance of agreement work by the unlisted class of employees, the Participant shall advise the Contracting Officer of the action taken but the other procedures in paragraph (b((2)(ii) of this section need not be followed.

(C) No employee engaged in performing work on this agreement shall in any event be paid less than the currently applicable minimum wage specified under section 6(a)(1) of the Fair Labor Standards Act of 1938, as amended.

(v) The wage rage and fringe benefits finally determined pursuant to paragraphs (b)(2)(i) and (ii) of this section shall be paid to all employees performing in the classification from the first day on which agreement work is performed by them in the classification. Failure to pay such unlisted employees the compensation agreed upon by the interested parties and/or finally determined by the Wage and Hour Division retroactive to the date such class of employees commenced agreement work shall be a violation of the Act and this agreement.

(vi) Upon discovery of failure to comply with paragraphs (b)(2)(i) through (v) of this section, the Wage and Hour Division shall make a final determination of conformed classification, wage rate, and/or fringe benefits which shall be retroactive to the date such class of employees commenced agreement work.

(3) If, as authorized pursuant to section 4(d) of the Service Contract Act of 1965 as amended, the term of this agreement is more than 1 year, the minimum monetary wages and fringe benefits required to be paid or furnished thereunder to service employees shall be subject to adjustment after 1 year and not less often than once every 2 years, pursuant to wage determinations to be issued by the Wage and Hour Division, Employment Standards Administration of the Department of Labor as provided in such Act.

(c) The participant or subcontractor may discharge the obligation to furnish fringe benefits specified in the attachment or determined conformably thereto by furnishing any equivalent combinations of bona fide fringe benefits, or by making equivalent or differential payments in cash in accordance with the applicable rules set forth in Subpart D of 29 CFR Part 4, and not otherwise.

34. LABOR STANDARDS FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

(d)(1) In the absence of a minimum wage attachment for this agreement, neither the Participant nor any subcontractor under this agreement shall pay any person performing work under the agreement (regardless of whether they are service employees) less than the minimum wage specified by section 6(a)(1) of the Fair Labor Standards Act of 1938. Nothing in this provision shall relieve the Participant or any subcontractor of any other obligation under law or contract for the payment of a higher wage to any employee.

(2) If this agreement succeeds a contract, subject to the Service Contract Act of 1965 as amended, under which substantially the same services were furnished in the same locality and service employees were paid wages and fringe benefits provided for in a collective bargaining agreement, in the absence of the minimum wage attachment for this agreement setting forth such collectively bargained wage rates and fringe benefits, neither the Participant nor any subcontractor under this agreement shall pay any service employee performing any of the agreement work (regardless of whether or not such employee was employed under the predecessor contract), less than the wages and fringe benefits provided for in such collective bargaining agreements, to which such employee would have been entitled if employed under the predecessor contract, including accrued wages and fringe benefits and any prospective increases in wages and fringe benefits provided for under such agreement. No Participant or subcontractor under this agreement may be relieved of the foregoing obligation unless the limitations of 4.1b(b) of 29 CFR Part 4 apply or unless the Secretary of Labor or his authorized representative finds, after a hearing as provided in 4.10 of 29 CFR Part 4 that the wages and/or fringe benefits provided for in such agreement are substantially at variance with those which prevail for services of a character similar in the locality, or determines, as provided in 4.11 of 29 CFR Part 4, that the collective bargaining agreement applicable to service employees employed under the predecessor contract was not entered into as a result of arm's-length negotiations. Where it is found in accordance with the review procedures provided in 29 CFR Part 4.10 and/or 4.11 and Parts 6 and 8 that some or all of the wages and/or fringe benefits contained in a predecessor contractor's collective bargaining agreement are substantially at variance with those which prevail for services of a character similar in the locality, and/or that the collective bargaining agreement applicable to service employees employed under the predecessor contract was not entered into as a result of arm's-length negotiations, the Department will issue a new or revised wage determination setting forth the applicable wage rates and fringe benefits. Such determination shall be made part of the agreement or subcontract, in accordance with the decision of the Administrator, the Administrative Law Judge, or the Board of Service Contract Appeals, as the case may be, irrespective of whether such issuance occurs prior to or after the award of an agreement or subcontract, 53 Comp. Gen. 401 (1973). In the case of a wage determination issued solely as a result of a finding of substantial variance, such determination shall be effective as of the date of the final administrative decision.

34. LABOR STANDARD FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

(e) The Participant and any subcontractor under this agreement shall notify each service employee commencing work on this agreement of the minimum monetary wage and any fringe benefits required to be paid pursuant to this agreement, or shall post the wage determination attached to this agreement. The poster provided by the Department of Labor (Publication WH 1313) shall be posted in a prominent and accessible place at the worksite. Failure to comply with this requirement is a violation of section 2(a)(4) of the Act and of this agreement. (Approved by the Office of Management and Budget under OMB control number 1215-0150).

(f) The Participant or subcontractor shall not permit any part of the services called for by this agreement to be performed in buildings or surroundings or under working conditions provided by or under the control or supervision of the Participant or subcontractor which are unsanitary or hazardous or dangerous to the health or safety of service employees engaged to furnish these services, and the Participant or subcontractor shall comply with the safety and health standards applied under 29 CFR Part 1925.

(g)(1) The Participant and each subcontractor performing work subject to the Act shall make and maintain for 3 years from the completion of the work records containing the information specified in paragraphs (g)(1)(i) through (vi) of this section for each employee subject to the Act and shall make them available for inspection and transcription by authorized representatives of the Wage and Hour Division. Employment Standards Administration of the U.S. Department of Labor, (Sections 4.6(g)(1)(i) through (iv) approved by the Office of Management and Budget under OMB control number 1215-0017 and sections 4.6(g)(1)(v) and (vi) approved under OMB control numbers 1215-0150.):

(i) Name and address and social security number of each employee.

(ii) The correct work classification or classifications, rate or rates of monetary wages paid and fringe benefits provided, rate or rates of fringe benefit payments in lieu thereof, and total daily and weekly compensation of each employee.

(iii) The number of daily and weekly hours so worked by each employee.

(iv) Any deductions, rebates, or refunds from the total daily or weekly compensation of each employee.

(v) A list of monetary wages and fringe benefits for those classes of service employees not included in the wage determination attached to this agreement but for which such wage rates or fringe benefits have been determined by the interested parties or by the Administrator or authorized representative pursuant to the labor standards clause in paragraph (b) of this section. A copy of the report required by the clause in paragraph (b)(2)(ii) of this section shall be deemed to be such a list.

34. LABOR STANDARD FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

(vi) Any list of the predecessor contractor's employees which had been furnished to the Participant pursuant to 4.6(1)(2).

(2) The Participant shall also make available copy inspection or transcription by authorized representatives of the Wage and Hour Division.

(3) Failure to make and maintain or to make available such records for inspection and transcription shall be a violation of the regulations and this agreement, and in the case of failure to produce such records, the Contracting Officer, upon direction of the Department of Labor and notification of the contractor, shall take action to cause suspension of any further payment or advance of funds until such violation ceases.

(4) The Participant shall permit authorized representatives of the Wage and Hour Division to conduct interviews with employees at the worksite during normal working hours.

(h) The Participant shall unconditionally pay to each employee subject to the Act all wages due free and clear and without subsequent deduction (except as otherwise provided by law or Regulations, 29 CFR Part 4), rebate, or kickback on any account. Such payments shall be made no later than one pay period following the end of the regular pay period in which such wages were earned or accured. A pay period under this act may not be of any duration longer than semi-monthly.

(i) The Contracting Officer shall withhold or cause to be withheld from the Government prime Participant under this or any other Government agreement or contract with the prime Participant such sums as an appropriate official of the Department of Labor requests or such sums as the Contracting Officer decides may be necessary to pay underpaid employees employed by the Participant or subcontractor. In the event of failure to pay any employees subject to the Act all or part of the wages or fringe benefits due under the Act, the agency may, after authorization or by direction of the Department of Labor and written notification to the Participant, take action to cause suspension of any further payment or advance of funds until such violations have ceased. Additionally, any failure to comply with the requirements of these clauses relating to the Service Contract Act of 1965, may be grounds for termination of the right to proceed with the agreement work. In such event, the Government may enter into other contracts or arrangements for completion of the work, charging the Participant in default with any additional cost.

(j) The Participant agrees to insert these clauses in this section relating to the Service Contract Act of 1965 in all subcontracts subject to the Act. The term "contractor" as used in these clauses in any subcontract, shall be deemed to refer to the subcontractor, except in the term "Government prime Participant."

34. LABOR STANDARD FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

(k)(1) As used in these clauses, the term "service employee" means any person engaged in the performance of this agreement other than any person employed in a bona fide executive, administrative, or professional capacity, as those terms are defined in Part 541 of Title 29, Code of Federal Regulations, as of July 30, 1976, and any subsequent revision of those regulations. The term "service employee" includes all such personal regardless of any contractor relationship that may be alleged to exist between a Participant or subcontractor and such persons.

(2) The following statement is included in agreements pursuant to section 2(a)(5) of the Act and is for informational purposes only.

The following classes of service employees expected to be employed under the agreement with the Government would be subject, if employed by the contracting agency, to the provisions of 5 U.S.C. 5341 or 5 U.S.C. 5332 and would, if so employed, be paid not less than the following rates of wages and fringe benefits:

(1)(1) If wages to be paid or fringe benefits to be furnished any service employees employed by the Government prime Participant or any subcontractor under the agreement are provided for in a collective bargaining agreement which is or will be effective during any period in which the agreement is being performed, the Government prime Participant shall report such fact to the Contracting Officer, together with full information as to the application and accrual of such wages and fringe benefits, including any prospective increases, to service employees engaged in work on the agreement and a copy of the collective bargaining agreement. Such report shall be made upon commencing performance of the agreement, in the case of collective bargaining agreements effective at such time, and in the case of such agreements or provisions or amendments thereof effective at a later time during the period of agreement performance, such agreements shall be reported promptly after negotiation thereof. (Approved by the Office of Management and Budget under OMB control number 1215-0150.)

(2) Not less than 10 days prior to completion of any agreement being performed at a Federal facility where service employees may be retained in the performance of the succeeding contract and subject to a wage determination which contains vacation or other benefit provisions based upon length of service with a contractor (predecessor) or successor (4.173 of Regulations, 29 CFR Part 4), the incumbent prime Participant shall furnish to the Contracting Officer a certified list of the names of all service employees on the Participant's or subcontractor's payroll during the last month of agreement performance. Such list shall also contain anniversary dates of employment on the agreement either with the current or predecessor contractors

34. LABOR STANDARD FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

of each such service employee. The Contracting Officer shall turn over such list to the successor contractor at the commencement of the succeeding contract. (Approved by the Office of Management and Budget under OMB control number 1215-0150.)

(m) Rulings and interpretations of the Service Contract Act of 1965, as amended are contained in Regulations, 29 CFR Part 4.

(n)(1) By entering into this agreement, the Participant (and officials thereof) certifies that neither it (nor he or she) nor any person or firm who has a substantial interest in the Participant's firm is a person or firm ineligible to be awarded Government agreements by virtue of the sanctions imposed pursuant to section 5 of the Act.

(2) No part of this agreement shall be subcontracted to any person or firm ineligible for award of a Government contract pursuant to sectin 5 of the Act.

(3) The penalty for making false statements in prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

(o) Notwithstanding any of the clauses in paragraphs (b) through (m) of this section relating to the Service Contract Act of 1965, the following employees may be employed in accordance with the following variations, tolerances, and exemptions, which the Secretary of Labor, pursuant to section 4(b) of the Act prior to its amendment by Pub. L. 92-473, found to be necessary and proper in the public interest or to avoid serious impairment of the conduct of Government business:

(1) Apprentices, student-learners, and workers whose earning capacity is impaired by age, physical, or mental deficiency or injury may be employed at wages lower than the minimum wages otherwise required by section 2(a)(1) or 2(b)(1) of the Service Contract Act without diminshing any fringe benefits or cash payments in lieu thereof required under section 2(a)(2) of that Act, in accordance with the conditions and procedures prescribed for the employment of apprentices, student-learners, handicapped persons, and handicapped clients of sheltered workshops under section 14 of the Fair Labor Standards Act of 1938, in the regulations issued by the Administrator (29 CFR Parts 520, 521, 524, and 525).

(2) The Administrator will issue certificates under the Service Contract Act for the employment of apprentices, student-learners, handicapped persons, or handicapped clients of sheltered workshops not subject to the Fair Labor Standards Act of 1938, or subject to different minimum rates of pay under the two acts, authorizing appropriate rates of minimum wages (but without changing requirements concerning fringe benefits or supplementary cash payments in lieu thereof), applying procedures prescribed by the applicable regulations issued under the Fair Labor Standards Act of 1938 (29 CFR Parts 520, 521, 524, and 525).

34. LABOR STANDARD FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

(3) The Administrator will also withdraw, annul, or cancel, such certificates in accordance with the regulations in Parts 525 and 528 of Title 29 of the Code of Federal Regulations.

(p) Apprentices will be permitted to work at less than the predetermined rate for the work they perform when they are employed and individually registered in a bona fide apprenticeship program registered with a State Apprenticeship Agency which is recognized by the U.S. Department of Labor, or if no such recognized agency exists in a State, under a program registered with the Bureau of Apprenticeship and Training, Employment and Training Administration, U.S. Department of Labor. Any employee who is not registered as an apprentice in an approved program shall be paid the wage rate and fringe benefits contained in the applicable wage determination for the journeyman classification of work actually performed. The wage rates paid apprentices shall not be less than the wage rate for their level of progress set forth in the registered program, expressed as the appropriate percentage of the journeyman's rate contained in the applicable wage determination. The allowable ratio of apprentices to journeymen employed on the agreement work in any craft classification shall not be greater than the ratio permitted to the Participant as to its entire work force under the registered program.

(q) An employee engaged in an occupation in which he or she customarily and regularly receives more than $30 a month in tips may have the amount of tips credited by the employer against the minimum wage required by section 2(a)(1) or section 2(b)(1) of the Act in accordance with section 3(m) of the Fair Labor Standards Act and Regulations, 29 CFR Part 531: Provided, however, That the amount of such credit may not exceed $1.24 per hour beginning January 1, 1980, and $1.34 per hour after December 31, 1980. To utilize this proviso:

(1) The employer must inform tipped employees about this tip credit allowance before the credit is utilized:

(2) The employees must be allowed to retain all tips (individually or through a pooling arrangement and regardless of whether the employer elects to take a credit for tips received):

(3) The employer must be able to show by records that the employee received at least the applicable Service Contract Act minimum wage through the combination of direct wages and tip credit; (approved by the Office of Management and Budget under OMB control number 1215-0017);

(4) The use of such tip credit must have been permitted under any predecessor collective bargaining agreement applicable by virtue of section 4(c) of the Act.

34. LABOR STANDARD FOR FEDERAL SERVICE AGREEMENTS (Cont'd)

(r) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this agreement shall not be subject to the general disputes clause of this agreement. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 4, 6, and 8. Disputes within the meaning of this clause include disputes between the Participant (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or employees or their representatives.

GEO-North

Statement of Work

1.0 Introduction

The Cascade volcanic region has long been suspected to contain considerable geothermal potential, as evidenced by recent volcanism and other thermal expressions. There are few known surface manifestations of geothermal energy in spite of the obvious occurrence of heat sources. One possible explanation is that the downward percolation of the extensive regional cold ground-water system suppresses surface evidence of underlying hydrothermal systems. However, there have been few wells drilled in the Cascades region to a sufficient depth to properly evaluate the temperature and hydrological conditions beneath the cold water zone. There is a great need for characterization identification of the deeper hydrothermal regime in order to more conclusively define the geothermal potential of the Cascades volcanic environment.

2.0 Scope

DOE's primary objectives for this cost-shared drilling project are to obtain and release to the public subsurface information, to include but not limited to the following:

- o rock samples (core and/or drill chips),
- o equilibrium temperature profiles,
- o uncontaminated fluid samples,
- o evidence for the existence and depth of potentially producible aquifers,
- o geophysical well logs, and
- o information on drilling conditions and problems in the Cascades environment.

The Participant will drill a deep thermal gradient hole to a depth of 4000 feet located 4,100 feet north and 500 feet east of the southwest corner of section 24, T20S, R12E, Deschutes County, Oregon. The Participant will perform data collection both during and subsequent to drilling. The Participant will maintain the hole and allow DOE access to the hole to collect data. The Participant will be responsible for obtaining any permits or approvals required by government regulatory agencies in the performance of this project. The Participant will provide all data and information gathered under this project to DOE.

3.0 Applicable Documents

Work performed by the Participant will be in compliance with all Federal, State, and local laws, rules and regulations, and agency orders and guidelines.

4.0 Technical Tasks

4.1 Project Management

A. The Participant will prepare and obtain DOE approval of a Project Management Plan within 30 days after award of this agreement. The plan will include a work breakdown structure and a list of deliverables by task, identify the individuals and subcontractors responsible for each task, discuss the management techniques to be used, and include a schedule that shows the period for performance of each subtask and identifies principal milestones and decision points for each. The plan will also designate an individual or individuals who will act as principal points of contact with DOE on behalf of the Participant.

B. The Participant will perform project management in accordance with the approved Project Management Plan. In addition to close general coordination with DOE, immediate and full disclosure of any project problem areas to DOE is required, so that timely corrective action may be taken with DOE technical support, if necessary.

Deliverable: Approved Project Management Plan

4.2 Permitting and Environmental Reporting

A. The Participant will submit and obtain DOE approval of a Project Institutional Plan prior to initiation of site preparation. The plan will identify items required by governmental regulatory agencies for the performance of this work, the agency whose requirement the item fulfills, and the actual or projected submittal and agency approval dates. The plan will also discuss any legal, social or institutional problems anticipated during performance of the project and planned solution.

B. The Participant will prepare, submit and obtain approval of any documentation required by governmental regulatory agencies for the performance of this work. The Participant will provide a copy of all documentation provided to any governmental agency and pertinent to this project to DOE for information.

C. An approved environmental document is required for this project prior to any ground disturbance. It is anticipated that an environmental assessment will be prepared by the Bureau of Land Management for this project. This environmental assessment may satisfy DOE's environmental reporting requirements. If DOE determines that an Environmental Evaluation Report is required prior to any ground disruptive activity, DOE will notify the Participant in writing. In that event, the Participant will prepare the Environmental Evaluation Report in accordance with DOE Environmental Guidelines. If a DOE Environmental Assessment is required, the Participant will provide information to DOE as required for DOE's preparation of the Environmental Assessment.

Deliverables: Approved Project Institutional Plan, Regulatory Documentation, Approved Environmental Document

4.3 Drilling

A. The Participant will prepare and obtain DOE approval of a Project Drilling Plan prior to drilling. The plan shall describe:

- o Surface and subsurface conditions anticipated to be encountered during drilling, including configuration of the resource.
- o Site access.
- o Site preparation.
- o Hole design including hole size, casing size, cementing, etc.
- o Rig and equipment specifications.
- o Well containment during and after drilling (including applicable regulatory requirements).
- o Drilling fluids and disposal method.
- o Hole completion.
- o Plugging and abandonment.
- o Site restoration.
- o Anticipated hole problems, if any, and proposed solutions.

- o Health, safety and environmental considerations.
- o Site facilities, if any.
- o Drilling schedule including major activities and estimated duration.
- o On-site supervision to be used during drilling, including drilling supervisor(s) and geologist(s).

B. The Participant will prepare a drill site and drill a deep thermal gradient hole in accordance with the approved Project Drilling Plan. The Participant shall report on drilling status daily to the designated DOE representative, so that decisions concerning the drilling operation can be made in a timely manner.

Deliverable: Approved Project Drilling Plan

4.4 Data Collection

A. The Participant will prepare and obtain DOE approval of a Project Data Collection Plan prior to drilling. This plan will address data collection both during drilling and after drilling. The plan will identify the types of data to be collected, the depth(s) at which each type of data will be collected, the timing of collection, and the method by which the Participant plans to collect each type of data (including type of instrument and planned calibration, where appropriate). The plan will specifically identify all logs, samples of rock and fluid and other data that are to be collected.

B. The Participant will collect the following data as a minimum in accordance with the approved Project Data Collection Plan. These samples and data shall be provided to DOE by the Participant as soon as possible after collection. The Participant will incorporate its analysis and interpretation of the data collected as part of the final project report.

Rock Sampling. Cuttings will be collected at 15-foot intervals in the section of the hole to be rotary drilled. Four (4) splits of cutting samples of each sampled interval will be provided to DOE. The remainder of the hole will be continuously cored. The Participant will warehouse the core and cuttings in Bend and make them available to DOE. DOE will provide procedures for identification and splitting of core and cuttings. The Participant will make thin sections of selected core samples and complete a petrographic study of

these sections. The Participant will also select core samples for age dating. The results of these studies will be made available to DOE.

Drilling Records. Logs describing primary lithology and secondary mineral content and mud return temperatures will be kept during the tricone drilling and core portion of the hole, copies of which will be provided to DOE. These logs will also include information on lost circulation amounts, times and depths and/or the location of water entries.

Temperature. The bottomhole temperature shall be recorded at a minimum of 100 ft. intervals during drilling and preferably at least every other change of core barrel. One objective of these measurements will be to obtain a useable temperature profile in the event a subsequent equilibrium temperature profile cannot be obtained. The measurements shall be made using calibrated thermometers.

Hydraulic head. At the start of daily drilling, or whenever the drilling operation will allow, measurements of the hydraulic head or depth to fluid surface in the hole will be made.

Drilling fluid samples. An appropriate number of sets of one-liter samples of drilling fluid will be collected every trip for bit during drilling. Additional fluid samples will be collected when warranted by geologic conditions. One set will be delivered to DOE for possible analysis. If the Participant analyzes samples, copies of the results will be given to DOE.

Aquifer fluid samples. If artesian flow is encountered during drilling, representative samples of uncontaminated aquifer fluid will be collected in accordance with procedures outlined in the approved Data Collection Plan. If no artesian flow is encountered, the Participant will still endeavor to collect samples of uncontaminated aquifer fluids at locations in the hole at which fluid production would be anticipated on the basis of lost circulation, indications of fracturing in the core or chips, geophysical well logs or other standard indicators. Potential methods for collection of these samples include swabbing, bailing, airlift, drill stem tests and pumping. The Participants will examine these and/or other fluid sampling techniques and address collection of these samples in the Project Data Collection Plan.

Geophysical well logging. Temperature, caliper, resistivity and self-potential logs will be run in the interval between the surface pipe and total depth. Density and sonic velocity logs will also be run if tools are available which can operate in the conditions encountered in the hole. The temperature tool capable of 0.01°F precision in measurement will be used to measure the geothermal gradient. One set of field prints will be sent to DOE as soon as available.

Detailed Mercury (Hg) Survey. A comprehensive 3-D analysis of Hg distribution at Newberry Volcano will be conducted analyzing Hg at 10 foot intervals throughout the corehole and the results compared with the published Hg soil survey of Hadden, et al. (1982, DOGAMI-BPA Coop. Agr. DE-AC79-82BP36734). The proposed study will be used to establish the theoretical basis for Hg surveys in geothermal exploration, provide data pertaining to the reliability, limitations, and general utility of such surveys, and provide insight into the relationship among fracture permeability, mercury distribution, magma bodies, and geothermal reservoirs.

A byproduct of the proposed Hg study will be "splits" of the samples for which Hg has been analyzed. These "splits" will be made available to DOE for analysis of other elements. Analyses and interpretation of these data will be conducted.

Deliverables: Approved Data Collection Plan, Data and Samples

4.5 Hole Completion and Maintenance

A. Upon satisfactory completion of openhole geophysical logging and sampling, standard black pipe, 2" ID, with a knockout plug at the bottom, will be run by the Participant from surface to total depth, filled with fresh water and capped. After allowing sufficient time for thermal equilibration to occur, the Participant will run a temperature log and derive a geothermal gradient.

B. Upon completion of the hole, DOE and the Participant shall review and discuss the data. The Participant will obtain the Project Manager's agreement prior to releasing the rig.

C. The Participant shall provide to DOE within 15 days of completion of the hole a schematic of the actual completed hole configuration.

D. The Participant shall maintain the hole and site facilities for 12 months after hole completion in accordance with the approved Project Drilling Plan. The hole and site facilities shall be made available to DOE during this period for DOE's scientific use. The Participant may also collect data during this period at its own expense and on a non-interference basis.

Deliverable: Completed Hole Configuration Schematic

4.6 Abandonment

The Participant will plug and abandon the hole in accordance with U.S. Bureau of Land Management requirements (Form 3200-9, #5) and other applicable regulations within the one month subsequent to the end of the DOE access period. The Participant shall provide DOE with a copy of the plug and abandonment plan as approved by the Bureau of Land Management. If for any reason the hole is not plugged and abandoned by the end of the period of the agreement, the hole becomes the legal and financial responsibility solely of the Participant. DOE will not cost-share costs incurred after the project period of this agreement.

Deliverable: Approved P&A Plan

4.7 Site Restoration

The Participant will clear the site, fill the pits, and restore the site in accordance with applicable state and federal regulation and as outlined in the approved Project Drilling Plan. The Participant shall provide DOE with confirmation of restoration activities and Bureau of Land Management or Forest Service approval.

5.0 Reports, Data and Other Deliverables

A. The Project Drilling Plan as required by Subtask 4.3.A.

B. The Project Data Collection Plan as required by Subtask 4.4.A.

C. The Project Management Plan as required by Subtask 4.1.A.

D. The Project Institutional Plan as required by subtask 4.2.A.

E. All data collected by the Participant under Task 4.4.

F. Regulatory documentation and approved environmental document under Subtasks 4.2.B and 4.2.C.

G. Completed hole completion schematic as required by Subtask 4.5.C.

H. Approved plug and abandonment plan as required by Task 4.6.

I. Project status and management reports as identified on DOE Form CR-537, Reporting Requirements Checklist. The described final technical report shall include a summary of drilling and completion and a section describing data collected along with a discussion of analysis and interpretation.

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE REPORTING CHECKLIST

FORM EIA-459A
(10/80)

FORM APPROVED
OMB NO. 1900-0127

1. Identification Number:	2. Program/Project Title:
DE-FC07-85ID12613	Cascade Geothermal Drilling - GEO North

3. Recipient:
GEO Operations Corporation

4. Reporting Requirements:	Frequency	No. of Copies	Addressees
PROGRAM/PROJECT MANAGEMENT REPORTING			
[X] Federal Assistance Milestone Plan	O	2,1,1	A, B, E
[ ] Federal Assistance Budget Information Form			
[X] Federal Assistance Management Summary Report	Q	1,1,1	A, B, C
[X] Federal Assistance Program/Project Status Report	Q	2,1,1	A, B, E
[X] Financial Status Report, OMB Form 269	Y;F	1,1,	B, C
TECHNICAL INFORMATION REPORTING			
[X] Notice of Energy RD&D	O,Y	1,1	B, D
[ ] Technical Progress Report			
[X] Topical Report	A	3,1,1,1	A, B, E, F
[X] Final Technical Report	F	*4,1,1,1	A, B, E, F

FREQUENCY CODES AND DUE DATES:

A - As Necessary; within 5 calendar days after events.
F - Final; ~~90 calendar days after the performance of the effort ends.~~ Upon completion of agreement
Q - Quarterly; within 30 days after end of calendar quarter or portion thereof.
O - One time after project starts; within 30 days after award.
X - Required with proposals or with the application or with significant planning changes.
Y - Yearly; 30 days after the end of program year. (Financial Status Reports 90 days).
S - Semiannually; within 30 days after end of program fiscal half year.

5. Special Instructions:

A draft of the Final Technical Report shall be submitted for review to the contracting officer at least 60 days prior to the final due date. Comments resulting from this review shall be resolved and the report revised accordingly prior to final submission to DOE. The Final Techincal Report shall be submitted with a camera-ready copy.

NOTE: Contracting officer copy shall list all distribution.

*Includes camera-ready copy.

6. Prepared by: (Signature and Date)	7. Reviewed by: (Signature and Date)

REPORT DISTRIBUTION LIST

DE-FC07-85ID12613

U. S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83401

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U.S. DEPARTMENT OF LABOR
EMPLOYMENT STANDARDS ADMINISTRATION
WAGE AND HOUR DIVISION
WASHINGTON, D.C. 20210

REGISTER OF WAGE DETERMINATIONS UNDER THE SERVICE CONTRACT ACT

By direction of the Secretary of Labor

W. M. Otter — Administrator

LOCALITY: State: OREGON OR; Area: Statewide

Wage determination number: 79-283 (Rev. 5) Date: APR 1 1984

Class of service employee	Minimum hourly wage	Fringe benefit payments
Employed on contracts for commerical drilling, coring operations, and exploratory test hole drilling services in the above locality:		
1. Driller tenders (laborers)		
Zone 1	$12.84	$4.75
Zone 2	13.49	4.75
Zone 3	13.99	4.75
Zone 4	14.54	4.75
Zone 5	15.59	4.75
2 Drill Doctor; Drill Operator, Air tracks,Cat drill, Wagon drills, Rubber-mounted drills and other similar types; strippers and Drillers (covers work in swinging stages, chairs or belts, under extreme conditions unusual to normal drilling, blasting, barring down, or sloping to move, set up, align laser beam.		
Zone 1	$13.49	4.75
Zone 2	14.14	4.75
Zone 3	14.64	4.75
Zone 4	15.19	4.75
Zone 5	16.24	4.75
		4.75

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EMPLOYMENT STANDARDS ADMINISTRATION
WAGE AND HOUR DIVISION
WASHINGTON, D.C. 20210

REGISTER OF WAGE DETERMINATIONS UNDER
THE SERVICE CONTRACT ACT
By direction of the Secretary of Labor

W. M. Otter — Administrator

LOCALITY — State: OREGON — OR
Area: Statewide

Wage determination number: 79-283 (Rev. 5) — Date: APR 11 1984

Class of service employee	Minimum hourly wage	Fringe benefit payments
3. Driller tender(power equipment operator)		
Zone 1	$15.18	$4.70
Zone 2	15.83	4.70
Zone 3	16.33	4.70
Zone 4	16.88	4.70
Zone 5	17.93	4.70
4. Churn drill and Earth Boring machine		
Zone 1	$15.74	4.70
Zone 2	16.39	4.70
Zone 3	16.89	4.70
Zone 4	17.44	4.70
Zone 5	18.49	4.70
5. Bulldozer; Drill Cat operator; Drill Doctor; Drill Doctor (bit grinder)		
Zone 1	$15.96	4.70
Zone 2	16.61	4.70
Zone 3	17.11	4.70
Zone 4	17.66	4.70
Zone 5	18.71	4.70

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By direction of the Secretary of Labor

W. M. Otter — Administrator

LOCALITY — State: OREGON (OR); Area: Statewide

Wage determination number: 79-283 (Rev. 5) — Date: APR 11 1984

Class of service employee	Minimum hourly wage	Fringe benefit payments
6. Bulldozer, twin engine (TC 12 and similar); Driller - Percussion, Diamond, Core, Cable, Rotary and similar type.		
Zone 1	$16.04	$4.70
Zone 2	16.69	4.70
Zone 3	17.19	4.70
Zone 4	17.74	4.70
Zone 5	18.79	4.70
7 Tandem Bulldozer, Quad - Nine and similar:		
Zone 1	$16.91	4.70
Zone 2	17.56	4.70
Zone 3	18.06	4.70
Zone 4	18.16	4.70
Zone 5	19.66	4.70

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LOCALITY — State: OREGON — OR
Area: Statewide

Wage determination number: 79-283 (Rev. 5) — Date APR 11 1984

Class of service employee	Minimum hourly wage	Fringe benefit payments
8. Dump trucks, side, end and bottom dumps, including Semi- trucks and trains or combinations thereof: 6 cu yds.and under; Solo Flat Bed and misc. Body trucks, 0-10 tons.		
Zone 1	$14.69	$4.19
Zone 2	15.34	4.19
Zone 3	15.84	4.19
Zone 4	16.39	4.19
Zone 5	17.44	4.19
9. "A" Frame or Hydra - lift truck with load bearing surface		
Zone 1	$14.74	4.19
Zone 2	15.39	4.19
Zone 3	15.89	4.19
Zone 4	16.44	4.19
Zone 5	17.45	4.19

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By direction of the Secretary of Labor

W. M. Otter — Administrator

LOCALITY — State: OREGON — OR
Area: Statewide

Wage determination number: 79-283 (Rev 5) — Date: APR 1 1 198

Class of service employee	Minimum hourly wage	Fringe benefit payments
10. Dump trucks, side, end and bottom dump, including Semi-trucks and Trains or combinations thereof: over 6 cu. yds. and including 10 cu yds.		
Zone 1	$14.79	$4.19
Zone 2	15.44	4.19
Zone 3	15.94	4.19
Zone 4	16.49	4.19
Zone 5	17.54	4.19
11. Low bed Equipment, Flat bed Semi-trailer, truck and trailers of doubles transporting equipment or wet or dry materials.		
Zone 1	$14.84	4.19
Zone 2	15.49	4.19
Zone 3	15.99	4.19
Zone 4	16.54	4.19
Zone 5	17.59	4.19

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LOCALITY — State: OREGON — OR
Area: Statewide

Wage determination number: 79-283 (Rev. 5) — Date: APR 11 1984

Class of service employee	Minimum hourly wage	Fringe benefit payments
12. Dump trucks, side, end and bottom dumps, including Semi- trucks and trains or combinations thereof; over 10 cu.yds. and including 20 cu. yds.		
Zone 1	$14.99	$4.19
Zone 2	15.64	4.19
Zone 3	16.14	4.19
Zone 4	16.69	4.19
Zone 5	17.74	4.19

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W. M. Otter — Administrator

LOCALITY	State: OREGON	OR
	Area: Statewide	

Wage determination number: 79-283 (Rev. 5) Date: APR 11 1984

Class of service employee	Minimum hourly wage	Fringe benefit payments			
		Health & Welfare	Vacation	Holiday	Other

*Zone Definitions

CITIES

Astoria	Hood River	Newport	Tillamook
Baker	Klamath Falls	Ontario	Vancouver
Bend	La Grande	Pendleton	
Brookings	Lakeview	Port Orford	
Burns	Longview	Reesdport	
Coos Bay	Madras	Roseburg	
Goldendale	Medford	The Dalles	
Grants Pass	McMinnville		

Zone 1 - All jobs or projects located within 10 miles of the respective City Hall

Zone 2 - More than 10 miles but less than 25 miles from the respective City Hall

Zone 3 - More than 25 miles but less than 35 miles from the respective City Hall

Zone 4 - More than 35 miles but less than 45 miles from the respective City Hall

Zone 5 - More than 45 miles but less than 75 miles from the respective City Hall

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LOCALITY	State: OREGON	OR
	Area: Statewide	
	Wage determination number: 79-283 (Rev. 5)	Date: APR 11 1984

Class of service employee	Minimum hourly wage	Fringe benefit payments			
		Health & Welfare	Vacation	Holiday	Other

*Zone definitions continued

Albany and Corvallis Only

Zone 1 - All jobs or projects located within 5 miles of the respective City Hall

Zone 2 - More than 5 miles but less than 25 miles from the respective City Hall

Zone 3 - More than 25 miles but less than 35 miles from the respective City Hall

Zone 4 - More than 35 miles but less than 45 miles from the respective City Hall

Zone 5 - More than 45 miles but less than 75 miles from the respective

Portland Only

Zone 1 - All jobs or projects located within 25 miles of the City Hall of Portland

Zone 3 - More than 25 miles but less than 35 miles from City Hall

Zone 4 - More than 35 miles but less than 45 miles from City Hall

Zone 5 - More than 45 miles but less than 75 miles from City Hall

U.S. DEPARTMENT OF LABOR
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WAGE AND HOUR DIVISION
WASHINGTON, D.C. 20210

REGISTER OF WAGE DETERMINATIONS UNDER
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By direction of the Secretary of Labor

W. M. Otter — Administrator

LOCALITY	State: OREGON	OR
	Area: Statewide	
Wage determination number: 79-283 (Rev. 5)	Date: APR 11 1984	

Class of service employee	Minimum hourly wage	Fringe benefit payments			
		Health & Welfare	Vacation	Holiday	Other

*Zone definitions continued

Eugene and Salem Only

Zone 1 - All jobs or projects located within 20 miles of the respective City Hall

Zone 2 - More than 20 miles but less than 25 miles from the respective City Hall

Zone 3 - More than 25 miles but less than 35 miles from the respective City Hall

Zone 4 - More than 35 miles but less than 45 miles from the respective City Hall

Zone 5 - More than 45 miles but less than 75 miles from the respective City Hall

NEIL GOLDSCHMIDT
GOVERNOR

Department of Geology and Mineral Industries
ADMINISTRATIVE OFFICE
910 STATE OFFICE BLDG., 1400 SW 5th AVE., PORTLAND, OR 97201-5528 PHONE (503) 229-5580

April 4, 1988

Michael Wright
University of Utah Research
Earth Science Laboratory
391 Chipeta Way, Suite C
Salt Lake City UT 84108

Dear Michael:

Enclosed is a copy of a whole-rock analysis of a basalt lava at a depth of 3403 ft in the N-1 drill hole at Newberry Volcano (sample N-1 on enclosed sheet). I requested this sample from Bruce Sibbett in order to determine whether the hole had intercepted any John Day basalt.

As you can see the anaylsis is not indicative of the highly alkaline, titania-rich basalts of the John Day Formation. This rock is a rather typical calc-alkaline basaltic andesite similar to many basaltic andesites of the Cascades.

I hope this data is of some use to you.

Best regards,

George R. Priest

George R. Priest
Regional Geologist

encl.
CC Chandler Swanberg
Edward Taylor
Brittian Hill
Gary Smith
David Sherrod
Larry Chitwood

SAMPLE \ %	SIO2	AL2O3	CAO	MGO	NA2O	K2O	FE2O3	MNO	TIO2	P2O5	LOI	SUM
** N-1	53.2	16.5	8.50	4.44	3.64	0.66	8.85	0.15	1.26	0.29	1.31	98.9
AVB-1	0.41	0.03	51.9	4.03	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.1	99.6
AVB-1A	0.40	0.02	51.7	4.06	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.2	99.5
AVB-2	0.56	0.05	54.6	1.99	<0.01	0.02	<0.01	<0.01	<0.01	0.03	43.1	100.4
AVB-3	0.64	0.11	52.2	2.88	<0.01	0.02	0.02	<0.01	<0.01	0.09	42.9	98.9
AVB-4	0.88	0.20	49.9	4.62	<0.01	0.04	0.03	<0.01	<0.01	0.07	43.1	98.9
AVB-5	1.57	0.14	45.8	8.11	<0.01	0.04	0.03	<0.01	<0.01	0.10	43.1	98.9
AVB-6	0.84	0.19	52.5	3.39	<0.01	0.05	<0.01	<0.01	<0.01	0.09	43.2	100.3
AVB-7	0.75	0.22	49.0	6.59	0.02	0.05	0.01	<0.01	0.01	0.11	43.0	99.8
AVB-8	0.48	0.04	53.9	2.54	<0.01	0.02	<0.01	<0.01	<0.01	0.13	42.8	99.9
AVB-9	0.31	0.02	49.6	6.06	<0.01	0.02	<0.01	<0.01	<0.01	0.08	43.2	99.3
AVB-10	4.42	0.06	50.8	2.54	<0.01	0.03	<0.01	<0.01	<0.01	0.06	41.5	99.4
AVB-10A	4.50	0.08	51.0	2.56	<0.01	0.03	0.01	<0.01	<0.01	0.06	41.4	99.7
AVB-11	0.87	0.05	54.0	1.79	<0.01	0.03	<0.01	<0.01	<0.01	0.09	42.4	99.3
AVB-12	1.68	0.07	46.7	7.64	<0.01	0.03	<0.01	<0.01	<0.01	0.06	42.9	99.1
AVB-13	0.24	<0.01	55.6	0.72	<0.01	0.02	<0.01	<0.01	<0.01	0.03	42.5	99.1
AVB-14	0.17	<0.01	55.9	0.38	<0.01	0.02	<0.01	<0.01	<0.01	0.05	42.6	99.2
AVB-15	0.18	<0.01	55.5	0.33	<0.01	0.02	<0.01	<0.01	<0.01	0.02	42.9	99.0
AVB-16	0.29	0.02	55.6	0.42	<0.01	0.02	<0.01	<0.01	<0.01	0.03	42.5	98.9
AVB-17	0.46	<0.01	55.6	0.26	<0.01	0.02	<0.01	<0.01	<0.01	0.02	42.8	99.2
AVB-18	0.49	<0.01	55.8	0.23	<0.01	0.02	<0.01	<0.01	<0.01	0.02	42.5	99.1
AVB-19	1.08	<0.01	55.8	0.37	<0.01	0.02	<0.01	<0.01	<0.01	0.03	42.1	99.4
AVB-20	0.38	0.02	51.7	4.10	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.0	99.3
AVB-20A	0.39	0.02	51.9	4.12	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.0	99.5
AVB-21	0.47	0.04	48.0	7.36	<0.01	0.03	<0.01	<0.01	<0.01	0.04	43.5	99.5
AVB-22	0.26	<0.01	55.7	0.52	<0.01	0.02	<0.01	<0.01	<0.01	0.03	43.0	99.6
AVB-23	2.63	<0.01	55.2	0.27	<0.01	0.02	<0.01	<0.01	<0.01	0.36	41.6	100.1
AVB-24	11.8	0.14	49.2	0.36	<0.01	0.03	0.06	<0.01	0.01	0.05	37.9	99.6
AVB-25	4.76	0.95	52.8	0.75	<0.01	0.15	0.41	<0.01	0.03	0.12	39.5	99.5
AVB-26	2.81	0.09	54.4	0.56	<0.01	0.02	0.01	<0.01	<0.01	0.17	41.5	99.6
AVB-27	1.32	0.29	53.8	0.38	<0.01	0.09	0.10	<0.01	0.02	1.98	41.5	99.5
AVB-28	1.37	0.17	54.4	0.37	<0.01	0.06	0.09	<0.01	0.01	1.56	41.6	99.7
AVB-29	0.30	<0.01	55.5	0.43	<0.01	0.02	<0.01	<0.01	<0.01	0.14	42.2	98.6
AVB-30	1.86	0.26	36.0	17.5	<0.01	0.02	0.19	0.05	0.02	0.04	44.5	100.5
AVB-30A	1.90	0.27	35.8	17.6	<0.01	0.02	0.16	0.05	0.02	0.04	44.4	100.3
AVB-31	4.05	0.29	32.7	19.1	<0.01	0.03	0.22	0.04	0.01	0.04	43.7	100.2
AVB-32	22.3	0.07	43.6	0.17	<0.01	0.03	0.17	<0.01	<0.01	0.04	33.8	100.2
AVB-33	5.47	0.77	35.7	14.2	<0.01	0.03	0.94	0.19	0.04	0.04	42.7	100.1
AVB-34	9.81	0.45	49.5	0.67	<0.01	0.02	0.27	<0.01	0.02	0.02	39.4	100.2
AVB-35	2.65	0.33	43.6	9.84	<0.01	0.02	0.68	0.14	0.01	0.03	43.2	100.5
AVB-36	7.60	0.29	51.0	0.44	<0.01	0.05	0.18	0.03	0.01	0.03	40.5	100.2
AVB-37	2.29	0.45	54.0	0.31	<0.01	0.05	0.39	0.02	0.07	0.04	41.6	99.3
AVB-38	1.71	0.50	54.5	0.29	<0.01	0.08	0.27	<0.01	0.10	0.04	42.5	100.0
AVB-39	8.22	2.06	48.2	0.45	0.23	0.26	1.75	0.04	0.42	0.12	37.9	99.7
AVB-40	26.1	<0.01	30.1	18.5	<0.01	0.01	<0.01	<0.01	<0.01	0.10	25.5	100.3
AVB-40A	26.2	<0.01	30.0	18.6	<0.01	0.02	0.02	<0.01	<0.01	0.10	25.5	100.5

XRF W.R.A. SUMS INCLUDE ALL ELEMENTS DETERMINED. FOR SUMMATION, ELEMENTS ARE CALCULATED AS OXIDES

SAMPLE \ PPM	CR	RB	SR	Y	ZR	NB	BA
N-1	105	23	428	28	88	20	263
AVB-1	<10	10	262	<10	<10	<10	20
AVB-1A	<10	16	277	<10	<10	<10	26
AVB-2	<10	<10	232	<10	<10	15	42
AVB-3	<10	15	110	<10	<10	<10	34
AVB-4	<10	14	166	<10	<10	<10	80
AVB-5	<10	<10	256	<10	<10	11	39
AVB-6	<10	11	262	<10	<10	<10	75
AVB-7	<10	<10	274	<10	<10	<10	93
AVB-8	<10	<10	263	<10	<10	12	42
AVB-9	<10	<10	198	<10	<10	<10	37
AVB-10	<10	<10	249	<10	<10	<10	51
AVB-10A	<10	<10	256	<10	<10	<10	<10
AVB-11	<10	<10	192	<10	<10	<10	45
AVB-12	<10	<10	198	<10	<10	15	90
AVB-13	<10	<10	196	<10	<10	<10	<10
AVB-14	<10	<10	218	<10	<10	<10	38
AVB-15	<10	<10	192	<10	<10	<10	46
AVB-16	<10	<10	229	<10	<10	<10	61
AVB-17	<10	<10	190	<10	<10	18	18
AVB-18	<10	<10	186	<10	<10	<10	37
AVB-19	<10	<10	177	<10	<10	<10	26
AVB-20	<10	<10	215	<10	<10	16	43
AVB-20A	<10	<10	227	<10	<10	12	48
AVB-21	<10	<10	188	<10	<10	<10	19
AVB-22	<10	<10	159	<10	<10	<10	42
AVB-23	<10	<10	490	<10	<10	11	16
AVB-24	<10	14	341	<10	<10	<10	27
AVB-25	<10	13	466	<10	<10	<10	37
AVB-26	<10	12	426	<10	<10	<10	28
AVB-27	<10	<10	277	23	<10	15	20
AVB-28	<10	<10	136	<10	<10	18	37
AVB-29	<10	<10	318	<10	<10	18	36
AVB-30	<10	<10	103	<10	<10	<10	17
AVB-30A	<10	<10	104	10	<10	<10	<10
AVB-31	<10	15	82	15	<10	<10	<10
AVB-32	<10	15	91	<10	<10	<10	64
AVB-33	<10	10	69	12	<10	16	35
AVB-34	<10	<10	373	10	<10	<10	43
AVB-35	<10	<10	105	10	<10	<10	<10
AVB-36	<10	<10	281	<10	<10	<10	99
AVB-37	<10	<10	329	<10	<10	10	26
AVB-38	<10	<10	347	<10	<10	<10	68
AVB-39	<10	22	395	<10	<10	11	118
AVB-40	<10	<10	150	<10	<10	<10	32
AVB-40A	<10	<10	134	<10	<10	12	25

XRAL

CERTIFICATE OF ANALYSIS

REPORT 3181

TO: STATE OF OREGON GEOLOGY & MINERAL INDUSTRIES
ATTN: GARY BAXTER
910 STATE OFFICE BUILDING
PORTLAND, OREGON 97201
USA

CUSTOMER No. 1368

DATE SUBMITTED
12-Nov-87

REF. FILE 30312-04

Total Pages 2

41 CR.ROCKS P.O. 65683 Proj. LIMESTONE

	METHOD	DETECTION LIMIT
WRMAJ %	WR	0.01
WRMIN PPM	WR	10.

X-RAY ASSAY LABORATORIES LIMITED

DATE 17-DEC-87

CERTIFIED BY .....

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

MEMORANDUM

TO: P. M. Wright

FROM: B. S. Sibbett

SUBJECT: Sample Library

DATE: December 9, 1986

The recommended way of marking the location of core samples taken would be to:

1. Place a wooden block in the core box with footage depth sampled, inches of core taken, and the person or company name of sampler marked on the wood block.

2. Record the same information on a 5 x 7 card or note paper placed in the sample library file.

Samples have been marked in this manner in the past, except they have not always been recorded in the file and some have failed to put their name on the wooden block.

The master index of cuttings and core samples in the library needs to be updated.

The index of proprietary core/cuttings should be kept separate from the index of public data holes.

Most the private samples are being shelved in a separate room in the SE part of the building (see floor plan Figure 1). If a locked door was put on this room, access to most private samples could be controlled.

Priorities for Destructive Sampling:

It is recommended that once sampling has been approved by UURI, that samples of 6 or less per 10 foot (box) of core could

be taken and recorded as above. This is a $\leq$ 5% sample cut of representative rock units. Sampling of thin, important units, such as clay altered tuff, should not exceed 10% of the unit thickness unless special clearance is obtained.

When more than 6" per box or 5% of the core is to be taken, the core should be sawed lengthwise to provide the split. Unit contacts which show contact relations, i.e., fault vs. depositional, should not be sampled unless sawed, and then only under UURI supervision.

Bruce S. Sibbett

Bruce S. Sibbett

BSS:leo

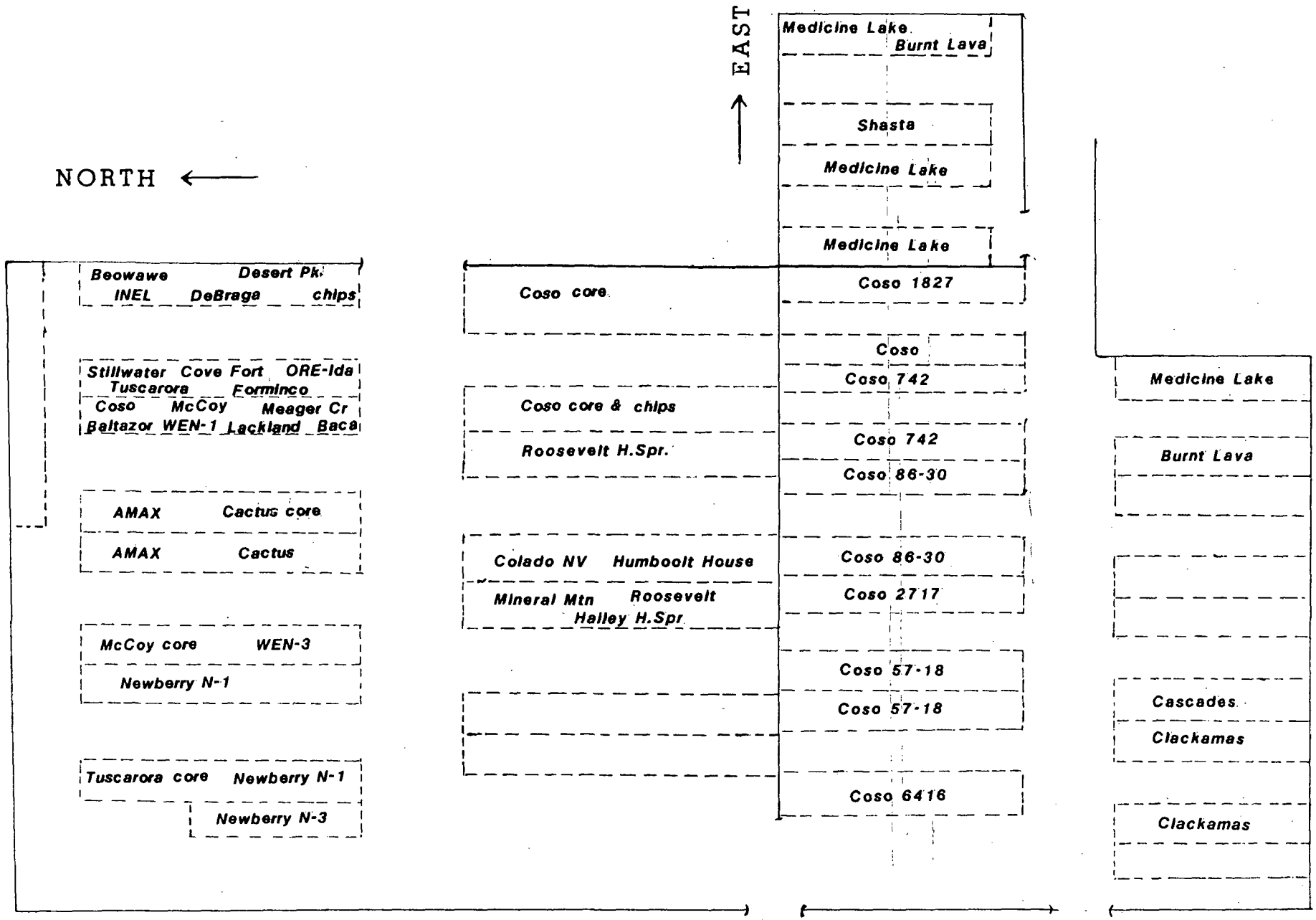


Figure 1. General layout and location of major sample groups in the ESL sample library.

GEO Operator Corporation
A Subsidiary of Geothermal Resources International, Inc.

December 24, 1986

P. M. Wright
University of Utah Research Institute
Earth Science Laboratory Division
391 Chipeta Way, Suite C
Salt Lake City, Utah 84108

RE: Core Hole GEO N-3
Cooperative Agreement No. DE-FC07-85ID12613
Additional Deliverables for Phase I

Dear Mike:

Attached herewith are the following items which should complete the package of Phase I "Deliverables" required under the subject contract:

1. Lithologic Log
2. Drillers Log
3. Hole Completion Schematic
4. Temperatures taken during drilling (from daily reports)
5. Hydraulic Head Data taken during drilling (from daily reports)
6. Additional Temperature Log - 8/18/86

All of the above represent figures, tables, or appendices from our final report and should be so referenced.

We are currently drafting the final figures from our N-1 final report and the preparation of that document is proceeding on course.

Sincerely,

Chandler A. Swanberg
Vice President
Non-Geysers Project Manager

CAS:yts
Enclosures

cc: J. Combs, GEO (w/o encl.)
W. Drake, DOE " "
R. King, DOE " "
S. Prestwich, DOE " "

GEO-Newberry Crater, Inc.
A Subsidiary of Geothermal Resources International, Inc.

Aug. 18, 1986

Dr. P. M. Wright
Utah University Research Institute
391 Chipeta Way, Suite C
Salt Lake City, Utah 84108

Dear Mike:

Attached are the following:

1. Core photographs for GEO N-3
2. Field copy of geophysical logs for GEO N-3

The additional data required under our contract will be forwarded to you shortly.

Very truly yours,

for Chandler Swanberg

Chandler A. Swanberg, President

CAS/rs

61419 South Highway 97, Suite A, Bend, OR 97701 (503) 389-6681

^rr nomore hardcopy
^RR?

Read or Scan: r nomore hardcopy

To: E.FEINAUER (DOE3401)
To: P.WRIGHT (DOE4433)
From: P.WRIGHT (DOE4433) Posted: Fri 30-Jan-87 13:06 EST Sys 64 (88)
Subject: REPLY TO GEO
Acknowledgment Sent

--More--

MEMO TO: SUE PRESTWICH

FROM: MIKE WRIGHT

SUBJECT: MATERIAL FOR REPLY TO GEO TO THEIR 23 DEC LETTER TO BILL DRAKE

Chan's letter to Bill Drake was rather testy, and I think we should respond in such a way as to defuse the situation somewhat, while at the same time making it clear that we still have not received all of the data. To this time, we have received nearly everything of real importance except the geophysical well logs. There apparently an honest mixup here. GEO thought they had delivered copies of the final logs to me when I was at their site in August to take possession of the core. This is what their letter of transmittal, which I brought back, says (see material attached to the letter of 23 Dec to Drake). However, I believe that the box they gave me contained only the photos of the core. I have called them and spoken to Rosemary, their secretary, who made contact with Chan. She called me back to say that they would sent a complete set of the logs in the mail right away. These should come in next week, and I will see that they are sent off to Rocky Mountain Well Log as soon as we get them. This will clear up this problem.

Things that remain lacking are the data from the mercury work and the age dating work. We should tell GEO that we would like copies of the mercury data even if they appear not to be useful to GEO. Regarding the age dates, you will remember that Chan talked about the topic and gave some dates ^rat the Northwest GRC meeting in Bend last fall. The dates are extremely valuable, and I would like to know if more dates are available than he presented and I think we should have a copy of the material he presented at that meeting for release on open file.

The following table, which is an update of the one in by November memo to you on this topic, shows what we have received to date and what we still think is lacking. I think we should strive to get as much of the missing material as possible without putting unnecessary stress on the (pretty) good relationship between GEO and DOE.

ITEM (see Note 1) N-1 N-2

1.	Core Samples (see Note 2)	D	D
2.	Results of age dating	N	N
3.	Results of petrographic studies	N	N
4.	Drilling records (see Note 3)	D	D
5.	Temperature during drilling	D	D
6.	Hydraulic head data	D	N
7.	Results of analysis of drill fluids	N	N
8.	Geophysical well logs (see Note 4)	D	D
9.	Detailed mercury survey	N	N
10.	Splits of mercury survey samples	N	N
11.	Photographs of core	D	D

D = Delivered N = Not Delivered to Date

Note 1. The contract broadly calls for all of the data and information generated by this project to be delivered to DOE, so a statement to that effect in any letter or call to GEO would be in order. They may have some items beyond what is on this list.

Note 2. GEO has retained some of the core samples which were unsplit. They have used these for their own studies in which unsplit core samples are preferable. ~ rThey say that these samples are available for others to use. We have noted the intervals they have retained. Otherwise, we have a complete split of the core at UURI.

Note 3. They have not delivered all of the information they said in their proposal that the drilling record would contain. We have no information on lost circulation amounts, times, depths, etc nor the location of water entries. I do not know whether they have these data and have not sent them or whether they did not collect some of these parameters.

Note 4. Chan told me that they had digital tapes of the Dresser logs for N-1, but they did not deliver these to me or to Rocky Mountain Well Log. If digital information exists, it would surely be worthwhile to have in the public domain. Digital data for the N-3 corehole would likewise be nice to have.

GEO Operator Corporation
A Subsidiary of Geothermal Resources International, Inc.

December 23, 1986

Mr. William C. Drake, Chief
R&D Contracts Branch
Contracts Management Division
US Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, Idaho 83402

RE: DATA FROM CORE HOLE GEO N-1
(Cooperative Agreement No. DE-FC07-85ID12612)

Dear Mr. Drake:

I am responding to your letter of December 12, 1986 regarding the above captioned data which was most disconcerting to GEO and appeared to have been written without benefit of the facts surrounding this industry-government joint geothermal research effort (see enclosures). All of the data, the "deliverables" required by DOE as part of Phase I (Drilling) were submitted to UURI on January 31, 1986 and I am attaching documentation to this effect (see enclosures). Our revised billing to DOE covering these same drilling activities was submitted February 6, 1986 (original billing was dated January 29, 1986) so that all deliverables were in the hands of DOE prior to the processing of our invoice.

We feel that our submission of the captioned data was timely and reasonable in that our submission was coordinated with and responsive to the release by UURI of the data to the general public. That is, the availability of the data was announced by UURI in the "Cascade Newsletter" #2 dated February 7, 1986 with actual access on February 24, 1986. In summary, the captioned data was "on the street" within 3-1/2 months after cessation of drilling operations.

Regarding core hole GEO N-3 (Cooperative Agreement DE-FC07-85ID12613), the Phase I data was submitted on August 18, 1986 (see attached), eighteen days after cessation of drilling operations. This date was also coordinated with UURI who took physical possession of the DOE core split at the same time. Our invoice covering Phase I drilling operations was not submitted to DOE until October 7, 1986. Careful inspection of our August 18th

1825 South Grant Street, Suite 900, San Mateo, CA 94402 (415) 349-8181

1/31/86 a. Geophysical logs
1/31/86 b. Temperature logs
1/31/86 c. Lithographic logs
1/31/86 d. Drillers log
1/31/86 e. Hole completion schematic
1/31/86 f. Temperatures measured during drilling
1/31/86 g. Hydraulic head data taken during drilling
1/31/86 h. Other data collected during Phase I

CORE PHOTOGRAPHS

$157,651.32

1825 South Grant Street. Suite 900. San Mateo. CA 94402 (415) 349-8181

Corehole GEO N-3

ARTICLE III - FINANCIAL SUPPORT

A. Estimated Cost. The total estimated cost of the work under this Agreement is Four Hundred Twenty-Nine Thousand Four Hundred Fifty-Five Dollars ($429,455). For performance of work under this Agreement, the agreed share ratio of total allowable costs is 49.5% DOE and 51.5% Participant. The Participant shall be reimbursed by DOE for not more than 49.5% of the costs of the project determined to be allowable in accordance with General Provisions, Section 29, entitled "Allowable Costs." The remaining 51.5% of the cost of the project so determined shall constitute the Participant's share for which it will not be reimbursed by DOE. If at any time the Participant has reason to believe that this or any revised estimate is in error, the Participant shall so notify DOE in writing and provide DOE with a new estimate with the next monthly Federal Assistance Management Summary Report.

B. DOE's Financial Support. The total cost to DOE for all the work under this project is Two Hundred Twelve Thousand Five Hundred Eighty Dollars ($212,580), and under no circumstances will DOE's support exceed this amount. This limitation includes termination costs, if any.

C. Participant's Financial Support. All costs in excess of the Two Hundred Twelve Thousand Five Hundred Eighty Dollars ($212,580) to be provided by DOE will be borne by the Participant. The estimated cost to the Participant is Two Hundred Sixteen Thousand Eight Hundred Seventy-Five Dollars ($216,875).

D. Obligated Funds. The amount of funds presently obligated to this Agreement by DOE is Two Hundred Twelve Thousand Five Hundred Eighty Dollars ($212,580).

ARTICLE IV - PAYMENTS

Progress Payments will be made on the basis of allowable costs incurred subject to the applicable cumulative ceiling. Invoices shall be submitted to DOE upon completion of each milestone.

Milestone	Maximum Cumulative Amount Payable by DOE
Phase I - Drilling	
1. Submittal of the following Phase I data:	
DATE SUBMITTED	
5/18/86 a. Geophysical logs	
5/18/86 b. Temperature logs	
** c. Lithographic logs	
** d. Drillers log	
** e. Hole completion schematic	
DAILY REPORTS f. Temperatures measured during drilling	
DAILY REPORTS g. Hydraulic head data taken during drilling	
3/10/86 h. Other data collected during Phase I	$158,439.57

CORE PHOTOGRAPHS

Geothermal Resources International, Inc.

7 October 1986

Mr. Ronald A. King
U.S. Department of Energy
785 DOE Place
Idaho Falls, Idaho 83402

RE: DOE Cascades Geothermal Drilling Program
Cooperative Agreement No. DE-FC07-85ID12612

Dear Ron,

Enclosed is GEO Operator Corporation's (GEOOC) statement for costs incurred during the drilling phase (Phase I) of corehole N-3 at Newberry Crater, Deschutes County, Oregon. Documentation supporting the statement is also included.

The documentation consists of vendor invoices and GEOOC employee expense reports. A summary of time devoted by Dr. Swanberg is also enclosed. Time reports for other employees are available upon your request. Lead schedules, summarizing the data in the supporting documents, are provided for each support type. Vendor invoices have been approved for payment (to vendors) by Dr. Swanberg. The GEOOC employee time sheets and expense reports were prepared on a timely basis and approved by management.

We allocate labor costs based upon the hours spent by employees on the various projects undertaken by the company. The rate used for each hour of labor by a salaried employee is based on the employee's monthly salary divided by the total hours worked that month. Therefore, the rate typically will fluctuate each month (depending on the number of hours worked). Employees receiving hourly wages are "charged out" to projects at their hourly wage. A burden rate of 27.78%, which covers all employee overhead, is assessed to every labor dollar committed through June 30, 1986. Effective July 1, 1986 the burden rate is 29.08%. Note that while costs incurred for the drilling phase of the project (Phase I) exceed the budgeted costs, our funding request is only for the amount DOE projected to pay. If possible, please transfer funds to the following account:

Bank of America
San Francisco, California
GEO Operator Corporation
#12331-07745

Should any questions exist in regards to the statement of cost, please contact me.

Sincerely,

Bruce K. Thiesen
Geothermal Accounting Manager

BKT:dap
Enclosure.
cc: Chandler A. Swanberg

GEO Operator Corporation
A Subsidiary of Geothermal Resources International, Inc.

STATEMENT OF COST

October 7, 1986

Period of Performance Covered by this billing — Cooperative Agreement No. DE-FC07-85ID12613

May 01, 1986 to September 30, 1986 — Voucher No. 1

Contract Amount: $429,455 Doe Share: $212,580 (49.5%) GEO Share: $216,875 (50.5%)

	Current	Cumulative
Consultants	$143,002.02	$143,002.02
Material	107,283.77	107,283.77
Direct Labor	22,073.04	22,073.04
Labor O/H	6,298.97	6,298.97
Travel/Living	11,278.58	11,278.58
Other	133,042.42	133,042.42
Sub-Total	$422,978.80	$422,978.80
G&A (7%)	29,608.52	29,608.52
Sub-Total	$452,587.32	$452,587.32
Less Cost Overrun	132,507.38	132,507.38
Sub-Total	$320,079.94	$320,079.94
Less GEO's Share (50.5%)	161,640.37	161,640.37
DOE Share (49.5%)	$158,439.57	$158,439.57
Less 10% Retention	15,843.96	15,843.96
Total Payment Due:	$142,595.61	$142,595.61

CERTIFICATION: I certify that this invoice is correct and in accordance with the terms of the Cooperative Agreement and that the costs included herein have been incurred, represent payments made by the participants except as otherwise authorized in the payments provisions of the Cooperative Agreements, and property reflect the work performed.

(Signature)

Vice President, Non-Geysers Project Manager
(Title)

1825 South Grant Street, Suite 900, San Mateo, CA 94402 (415) 349-8181

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108-1295
TELEPHONE 801-524-3422

MEMO TO: MARSHALL REED

FROM: MIKE WRIGHT

SUBJECT: BLACKWELL LOGGING IN THE CASCADES HOLES

DATE: 28 JAN 87

Enclosed is a copy of material sent to me by ID a few weeks ago. It is Dave Blackwell's report on his mapping project and a copy of the logs he took in the two holes at Newberry and the hole at Clackamas.

I think that these data show the bottom of the near-surface hydrologic zone in Newberry-1 at about the same level as we have been talking about before, namely about 1 km. However, the bottom of the near-surface hydrologic zone in Newberry-3 is much shallower, about 575 m. In both cases, the zone is well defined, with sharp increases in the temperature below. For Newberry-3, the isothermal zone at about 50 deg C below 575 m indicates vertical movement of water at this temperature, and seems quite anomalous.

In Thermal Power's hole at Clackamas, noted as Breitenbush by Blackwell, the picture is a bit different, with the bottom of the near-surface hydrologic zone about 300 m and with a gradual temperature increase below.

These data are interesting in terms of the hydrologic regime in the Cascades, and seem to indicate that just about anything can happen. In the Newberry area, we apparently have a case of different zones of high vertical permeability separated by zones that are quite impermeable, whereas at Clackamas, the section seems to be uniformly low in permeability and of uniform thermal conductivity.

U.S. DEPARTMENT OF ENERGY

FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

ORM EIA 459F
10/80)

FORM APPROVED
OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title	3. Reporting Period
DE-FG07-86ID12623	Geothermal Map of the United States	7-1-86 through 9-30-86

4. Name and Address
David D. Blackwell
Department of Geological Sciences, Southern Methodist University
Dallas, Texas 75275

5. Program/Project Start Date
11/1/85

6. Completion Date
9/30/87

7. Approach Changes

☐ None

8. Performance Variances, Accomplishments, or Problems

During the fourth quarter of the project work continued on the U.S. Geothermal map data base and field work was initiated for the Cascade Range cost shared part of the project. The map data base project is approaching completion although contributions from collaborators are lagging. Contributions from Marshall Reiter (Southwest), Ed Decker (Northeast and East) Doug Smith (Southeast), Will Gosnold (Midcontinent), Paul Morgan (Midwest), and Jim Witcher (Arizona and New Mexico) are expected, but not in hand.

During September 1986, temperature logs were made in several Cascade holes. Included were the Thermal Power CTHG-1 hole, and GeoOperator holes N-1 and N-3. A copy of the temperature-depth plots is included. The quality of the GeoOperators hole curves are poor due to intra-hole water flow induced by connecting confined aquifers (artesian in the case of N-3, and subhydrostatic in the case of N-1). To avoid this problem the holes should have been grouted. Gradients in all the holes are equal to or greater than the expected high regional values and so the results are encouraging. The temperature-depth logs for the CTHG-1 and N-3 wells are not at complete thermal equilibrium and so these holes, as well as the Cal-Energy hole currently drilling at Crater Lake, will need to be logged during the summer 1987.

☐ None

Samples were collected at the UURI core facility in Salt Lake City for thermal conductivity analysis. At the time of this report the preparation of the samples has begun.

9. Open Items

☐ None

10. Status Assessment and Forecast

The Cascade Study is on track. The map completions is behind schedule, but should be back on track by 12/15/86.

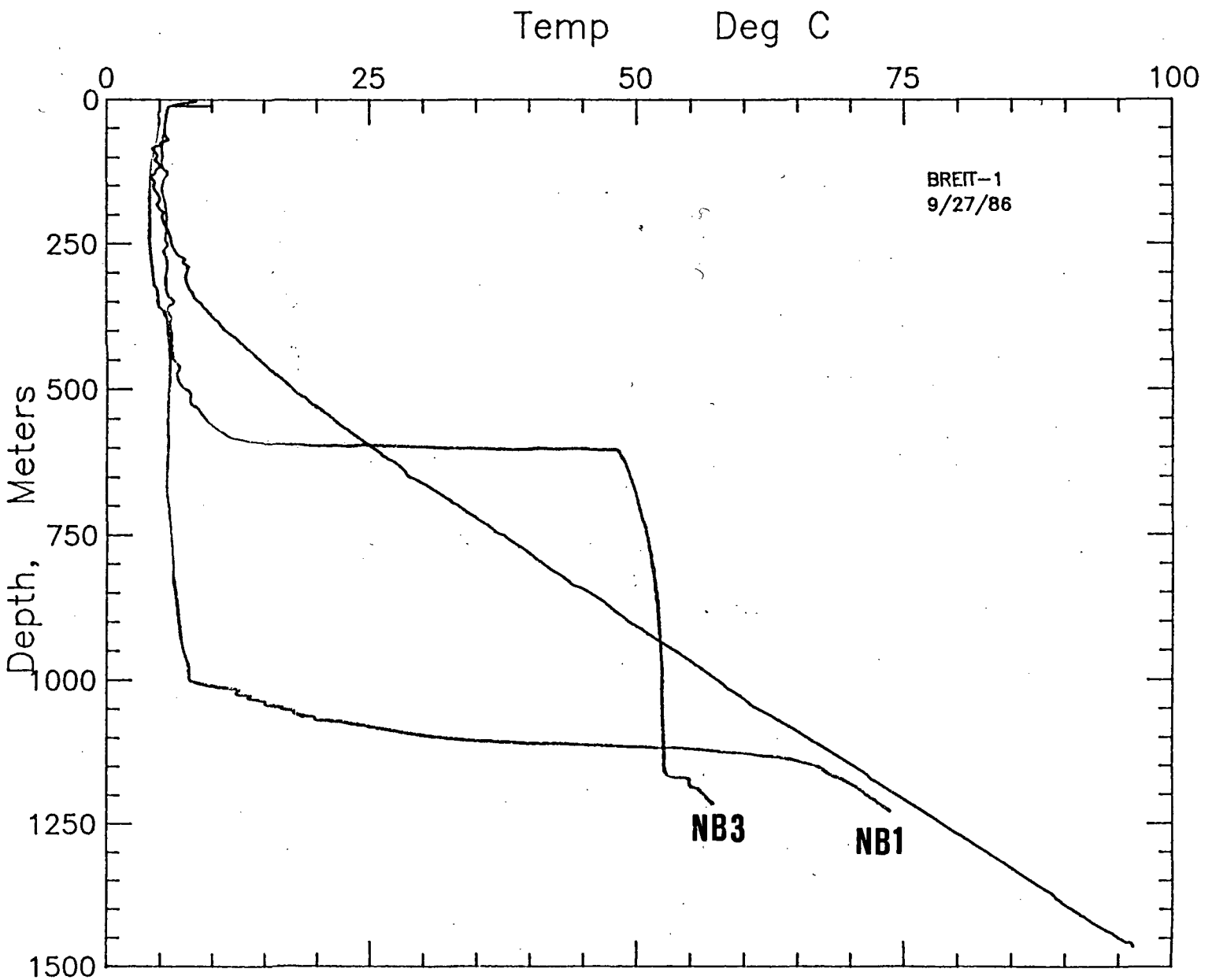
☐ No Deviation from Plan is Expected

11. Description of Attachments

Temperature-depth curve

☐ None

12. Signature of Recipient and Date	13. Signature of DOE Reviewing Representative and Date
Ted Bissell 12/8/86	


Temp Deg C
0
25
50
75
100
0
250
500
750
1000
1250
1500
Depth, Meters
BREIT-1
9/27/86
NB3
NB1

Mike Wright URI

United States Department of the Interior

BUREAU OF LAND MANAGEMENT

OREGON STATE OFFICE
P.O. Box 2965 (825 NE Multnomah Street)
Portland, Oregon 97208

IN REPLY REFER TO:
3260 (920)
OR 11987
OR 12004
OR 12442

JUL 16 1987

Jody Spooner
Environmental Coordinator
GEO-Operator Corporation
1330 North Dutton Avenue, Suite A
Santa Rosa, California 95401

Dear Ms. Spooner:

We have received and reviewed the completion reports and Notices of Intent to Abandon (NIA-Sundry Notices) for wells N-1, N-2, and N-3, transmitted by your letter dated July 14, 1987. Your Notices of Intent to Abandon will be accepted with the following additions:

Wells N-1 and N-2:

- All cement shall be placed in the hole by pumping through drill pipe or tubing.
- The cement used shall meet the requirements of API Class cements.
- Set a 200 foot plug (100 feet in and out) across the surface casing shoe or from 100 feet below the shoe to the surface.
- The casing shall be cut off six feet below ground or at the bottom of the cellar, then capped with a welded plate.

Well N-3:

The above additions for wells N-1 and N-2 apply also to well N-3. In addition, the water zone (acquifer) indicated in the area of about 3,750 feet in N-3 needs to be cemented off. To do this you will need to set, at minimum, a 200 foot cement plug from 3,650 feet to 3,850 feet.

After the holes have been plugged, the actual performance is to be documented with a Subsequent Report of Abandonment (SRA-Sundry Notice) in accordance with 43 CFR 3264.2-2.

It is also pointed out that the surface management agency is the US Forest Service and not BLM as marked on your completion reports.

If you have any questions, please call Steve Henderson, Petroleum Engineer, at (503) 231-2048.

Sincerely,

Leroy M. Mohorich
Acting Deputy State Director
for Mineral Resources

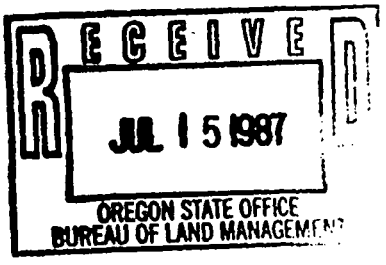
Mike Wright Utah R.I (DOE)
Susan Prestwich, DOE Idaho Falls
C.C. Dennis Olmstead per his request 7/17/87
DOE Amt

cc: Dennis Davis, Prineville DO
Dennis Simontacchi, Lakeview DO

Steve Henderson
Work Copy

GEO Operator Corporation
A Subsidiary of Geothermal Resources International, Inc.

July 14, 1987



VIA FEDERAL EXPRESS

Mr. Steve Henderson
U.S. Department of the Interior
Bureau of Land Management
Oregon State Office
Lloyd Center Tower Building
825 N.E. Multnomah Street, 15th Floor
Portland, OR 97208

Dear Mr. Henderson:

Re: Sundry Notices for Abandonment

Attahced is a copy of the package previously sent to Mr. Mohorich regarding gradient holes N-1, N-2 and N-3. I will be contacting you on Thursday.

Thank you for your assistance in this matter.

Sincerely,

Jody Spooner
Environmental Coordinator

JS/bMc
Enclosures
EN87-138.JS

GEO Operator Corporation
A Subsidiary of Geothermal Resources International, Inc.

July 7, 1987

U. S. Department of the Interior
Bureau of Land Management
Oregon State Office
825 N.E. Multnomah Street
P. O. Box 2965
Portland, OR 97208

Attention: Mr. Leroy Mohorich, Chief
Fluid Mineral Resources

Gentlemen:

Re: Sundry Notices for Abandonment
of N-1, N-2 and N-3

Enclosed please find the Geothermal Sundry Notices which contain proposed plans to abandon the above-mentioned holes. Also attached are the Completion Reports for each test hole. The downhole abandonment plans have been designed pursuant to Geothermal Resources Operational Order No. 3.

GEO is under contract with the Department of Energy to abandon N-1 and N-3 prior to August 1, 1987, and would like to abandon N-2 within the same time frame.

Please feel free to contact me if you have any questions. Your assistance in this matter is greatly appreciated.

Sincerely,

Jody Spooner
Environmental Coordinator

JS/bMc
Enclosures
EN87-131.JS

cc: Chan Swanberg, San Mateo
Pete Hansen, San Mateo
Cliff Walkey, Bend

Form: USGS 9-1958

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY, CONSERVATION DIVISION

Form Approved
Budget Bureau No. _____

GEOTHERMAL SURVEY NOTICE

The U.S. Geological Survey requests this form or other Supervisor approved form to be submitted in triplicate with requisite attachments with the Supervisor. The Supervisor must approve this permit prior to any lease operations.

4. LEASE SERIAL NO.: OR-12004

5. SURFACE MANAGER: BLM ( ) FS ( ) Other ( )

1a. WELL TYPE: PRODUCTION ( ) INJECTION ( ) HEAT EXCHANGE ( ) OBSERVATION (X) OTHER ( )

6. UNIT AGREEMENT NAME: Newberry Volcano Fla

1b. WELL STATUS: Permanent Abandonment

7. WELL NO.: N-1 8. PERMIT NO.: OR92085DNBC

2. NAME OF LESSEE/OPERATOR: GEO Newberry Crater, Inc.

9. FIELD OR AREA: Newberry Volcano

3. ADDRESS OF LESSEE/OPERATOR: 61419 S. Highway 97, Suite A, Bend, OR 97702

10. SEC. T., R., B.& M.: S25, T22S, R12E

11. COUNTY: Deschutes

12. STATE: Oregon

13. LOCATION OF WELL OR FACILITY: 3600' W and 2750' N of SW corner of S25, T22S, R12E

14. TYPE OF WORK

CHANGE PLANS	( )	CONVERT TO INJECTION	( )	PULL OR ALTER CASING	( )
SITE AND ROAD CONSTRUCTION	( )	FRACTURE TEST	( )	MULTIPLE COMPLETE	( )
CONSTRUCT NEW PRODUCTION FACILITIES	( )	SHOOT OR ACIDIZE	( )	ABANDON	XX
ALTER EXISTING PRODUCTION FACILITIES	( )	REPAIR WELL	( )	OTHER	( )

15. DESCRIBE PROPOSED OPERATIONS (Use this space for well activities only. See instructions for current well conditions on reverse)

Proposed operations for permanently abandoning GEO N-1 include the following:

1. Separate 1.9" O.D. tubing (J-55) from4" LP Flange by cutting with torch.
2. Remove 7-1/16 x 4-1/2" HW well head, 2" ball valves, and 4" LP flange from 4-1/2" HW regular casing.
3. Cement from surface 4-1/2" HW casing to a minimum depth of 15 meters (50 feet) measured from 2 meters (6 feet) below ground level with ASTM Type 1 &11 Portland Cement.
4. Cap casing by welding steel plate on stub.
5. Remove cellar cribbing.
6. Backfill cellar and restore surface area as specified by USFS.

16. DESCRIBE PROPOSED OPERATIONS (Use this space for all activities other than well work)

(Use reverse side if needed)

17. I hereby certify that the foregoing is true and correct

SIGNED _____ TITLE Environmental Coordinator DATE July 7, 1987

(This space for Federal use)

APPROVED BY _____ TITLE _____ DATE _____

CONDITIONS OF APPROVAL, IF ANY:

This permit is required by law (30 U.S.C. 1023); regulations: 30 CFR 270.34, 30 CFR 270.35, 30 CFR 270.48, 30 CFR 270.71-1, 30 CFR 270.72; Federal Geothermal Lease Terms and Stipulations and other regulatory requirements. The United States Criminal Code (18 U.S.C. 1001) makes it a criminal offense to make a willfully false statement or representation to any Department or Agency of the United States as to any matter within its jurisdiction.

CONFIDENTIAL

JUL 15 1987

OREGON STATE OFFICE
BUREAU OF LAND MANAGEMENT

Form: USGS 9-1960

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY, CONSERVATION DIVISION

GEOTHERMAL WELL COMPLETION REPORT

The U.S. Geological Survey requires this form or other Supervisor approved form to be prepared and filed in duplicate with requisite attachments with the Supervisor within 30 days after completion of permitted operations.

1a. WELL TYPE: PRODUCTION ( ) INJECTION ( ) DISPOSAL ( ) WATER SUPPLY ( ) OBSERVATION (X)
COLD ( ) HEAT EXCHANGE ( ) OTHER ( )

1b. COMPLETION: NEW (X) WORKOVER ( ) DEEPENED ( ) PLUGBACK ( ) RECALL ( )
RECOMPLETED ( ) DRILLED & ABANDONED ( ) OTHER ( )

2. NAME OF LESSEE/OPERATOR
GEO NEWBERRY CRATER, INC.

3. ADDRESS OF LESSEE/OPERATOR
61419 South Highway 97, Suite A, Bend OR 97702

4. LOCATION OF WELL
At Surface: 3600' West and 2750' North of SW corner of S25, T22S, R11E
At Top of Production Zone:
At Total Depth:

5. LEASE SERIAL NO.
OR-12004

6. SURFACE MANAGER: BLM (X) FS ( ) Other ( )

7. UNIT AGREEMENT NAME
Newberry Volcano Flank

8. WELL NO.
N-1

9. PERMIT NO.
OR-920-85-ONB

10. FIELD OR AREA
Newberry Volcano

11. SEC., T., R., B.&M.
S25, T22S, R11E

12. COUNTY
Deschutes

13. STATE
Oregon

14. SPUD DATE
8-23-85

15. DATE T.D. REACHED
11-1-85

16. COMPLETION DATE (Ready to produce)
N/A

17. ELEVATIONS: ESTIMATED (X) FINAL ( )
5840'
REFERENCE DATUM: GR (X) RAT ( ) DF ( ) KB ( ) RT ( ) CASTINGHEAD FLANGE ( ) OTHER ( )

18. TOTAL DEPTH
Measured: 4550'
True Vertical: NOT SURVEYED

19. DIRECTIONALLY DRILLED INTERVALS
N/A

20. PLUGBACK TOTAL DEPTH
Measured: N/A
True Vertical:

21. DRILLING MEDIA: AIR ( ) WATER ( ) MUD (X) FOAM ( ) OTHER ( )
List Characteristics:

22. SURVEYED INTERVALS
NONE

23. CORE SIZE AND INTERVALS
0-468' 4½" CASING
468'-4550' HQ 2.5"

24. LOG TYPE & INTERVALS: BHC Acoustic Fraclog (1788-4538); BHC Acoustiflog Gamma Ray (1788-4538); Caliper Log (1786-3427) and (402-1250); Differential Temperature log (0-4540); Gamma Ray (0-4544); Induction Log (0-4540) and (480-1250).

25. CASING RECORD

Size	Weight	Grade	Collars & Threads	Depths Set Top	Depths Set Shoe	Hole Size	Cementing Record (slurry volume)
4.5"	10.7 #/ft.	A-53	Diamond Drill Flush Joint 3 Threads in	Surf.	468'	5 5/8"	25 cu. ft.

26. LINER RECORD

Size	Weight	Grade	Collars & Threads	Top	Bottom	Perforated Intervals	Cementing Record (slurry volume)

27. TUBING RECORD

Size	Weight	Grade	Depth Set	Packer Depth
1.9" O.D 1.516" I.D.	2.9 #/ft	J-55	4542'	

28. CEMENT SQUEEZE, ACID, FRACTURE, ETC. (detail type, amount, intervals)
FILLED HOLE WITH ABANDONMENT MUD.

29. PERFORATION RECORD

Type	Total No.	Density (No./ft)	Size	Intervals

30. ATTACHMENTS & PREVIOUS SUBMITTALS: List all reports, surveys, tests and logs, not listed in item 24, which have resulted from drilling and completion operations. List relevant previously furnished data with date of submittal referenced.

31. WELL STATUS: PRODUCING ( ) SHUT-IN ( ) SUSPENDED ( ) INJECTION ( ) DISPOSAL ( ) HEAT EXCHANGE ( ) ABANDONED ( ) WATER SUPPLY ( ) OTHER (X)
TEMPERATURE OBSERVATION.

32. DO YOU CONSIDER THE WELL TO BE COMMERCIAL? EXPLAIN:

33. I hereby certify the information on this report and the attached information is complete and correct according to the best of my knowledge.

SIGNED: Cliff Walkey TITLE: PROJECTS COORDINATOR DATE: 4-6-87

This report is required by law (30 U.S.C. 1023); regulations: 30 CFR 270.33, 30 CFR 270.71; Federal Geothermal Lease Terms and Stipulations and other regulatory requirements. Failure to report in a timely prescribed manner can result in shutting down operations, suspension and or recommendation of cancellation of lease (30 U.S.C. 1011, 30 CFR 270.60, 43 CFR 3244.3). The United States Criminal Code (18 U.S.C. 1001) makes it a criminal offense

Form: USGS 9-1958

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY, CONSERVATION DIVISION

RECEIVED
JUL 15 1987
OREGON STATE OFFICE
BUREAU OF LAND MANAGEMENT

Budget Bureau No.

GEOTHERMAL SUNDRY NOTICE

The U.S. Geological Survey requests this form or other Supervisor approved form to be prepared and filed in triplicate with requisite attachments with the Supervisor. The Supervisor must approve this permit prior to any lease operations.

1a. WELL TYPE: PRODUCTION ( ) INJECTION ( ) HEAT EXCHANGE ( ) OBSERVATION (X) OTHER ( )

1b. WELL STATUS: Permanent Abandonment

2. NAME OF LESSEE/OPERATOR: GEO Newberry Crater, Inc.

3. ADDRESS OF LESSEE/OPERATOR: 61419 S. Highway 97, Suite A, Bend OR 97702

4. LOCATION OF WELL OR FACILITY: 2175' S and 1130' W of NE corner of S29, T21S, R12E

5. SURFACE MANAGER: BLM ( ) FS X Other ( )

6. UNIT AGREEMENT NAME: Newberry Volcano Flan

7. WELL NO.: N-2

8. PERMIT NO.: OR92086DNB

9. FIELD OR AREA: Newberry Volcano

10. SEC. T., R., B.& M.: S29, T21S, R12E

11. COUNTY: Deschutes

12. STATE: Oregon

14. TYPE OF WORK

CHANGE PLANS	( )	CONVERT TO INJECTION	( )	PULL OR ALTER CASING	( )
SITE AND ROAD CONSTRUCTION	( )	FRACTURE TEST	( )	MULTIPLE COMPLETE	( )
CONSTRUCT NEW PRODUCTION FACILITIES	( )	SHOOT OR ACIDIZE	( )	ABANDON	XX
ALTER EXISTING PRODUCTION FACILITIES	( )	REPAIR WELL	( )	OTHER	( )

15. DESCRIBE PROPOSED OPERATIONS (Use this space for well activities only. See instructions for current well conditions on reverse)

Proposed operations for permanently abandoning GEO N-2 include the following:

1. Separate 1.9" O.D. tubing (J-55) from 4" LP Flange by cutting with torch.
2. Remove 7-1/6 x 4-1/2" HW well head, 2" Ball valves, and 4" LP Flange from 4-1/2" HW regular casing.
3. Cement from surface 4-1/2" HW casing to a minimum depth of 15 meters (50 feet) measured from 2 meters (6 feet) below ground level with ASTM Type 1 and 11 Portland cement.
4. Cap casing by welding steel plate on stub.
5. Remove cellar cribbing.
6. Backfill cellar and restore surface area as specified by USFS.

16. DESCRIBE PROPOSED OPERATIONS (Use this space for all activities other than well work)

(Use reverse side if needed)

17. I hereby certify that the foregoing is true and correct

SIGNED [signature] TITLE ENVIRONMENTAL COORDINATOR DATE July 7, 1987

(This space for Federal use)

APPROVED BY _____ TITLE _____ DATE _____

CONDITIONS OF APPROVAL, IF ANY:

This permit is required by law (30 U.S.C. 1023); regulations: 30 CFR 270.34, 30 CFR 270.35, 30 CFR 270.46, 30 CFR 270.71-1, 30 CFR 270.72; Federal Geothermal Lease Terms and Stipulations and other regulatory requirements. The United States Criminal Code (18 U.S.C. 1001) makes it a criminal offense to make a willfully false statement or representation to any Department or Agency of the United States as to any matter within its jurisdiction.

Form: USGS 9-1968

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY, CONSERVATION DIVISION

RECEIVED
DEC 1-5 1987
OREGON STATE OFFICE
BUREAU OF LAND MANAGEMENT

GEOTHERMAL WELL COMPLETION REPORT

The U.S. Geological Survey requires this form or other Supervisor approved form to be prepared and filed in duplicate with requisite attachments with the Supervisor within 30 days after completion of permitted operations.

4. LEASE DESIGNATION: FEDERAL ( ) STATE ( ) PRIVATE (X) INDIAN ( )
5. SURFACE MANAGED: BLM (X) FS ( ) OTHER ( )

1a. WELL TYPE: PRODUCTION ( ) INJECTION ( ) DISPOSAL ( ) WATER SUPPLY ( ) OBSERVATION (X) COLD ( ) HEAT EXCHANGE ( ) OTHER ( )

6. UNIT AGREEMENT NAME: Newberry Flank

1b. COMPLETION: NEW (X) WORKOVER ( ) DEEPENED ( ) PLUGBACK ( ) REDRILL ( ) RECOMPLETED ( ) DRILLED & ABANDONED ( ) OTHER ( )

7. WELL NO.: GEO N-2
8. PERMIT NO.: OR 920-86 DN

2. NAME OF LESSEE/OPERATOR: GEO-Newberry Crater, Inc.

9. FIELD OR AREA: Newberry Crater

3. ADDRESS OF LESSEE/OPERATOR: 61419 South Highway 97, Suite A, Bend, OR 97702

10. SEC., T., R., B. & M.: S29, T21S, R12E

11. COUNTY: Deschutes

12. LOCATION OF WELL
At Surface: 2175'S & 1130'W of NE Corner of S29, T21S, R12E
At Top of Production Zone:
At Total Depth:

13. STATE: OR

14. SPUD DATE: 8-15-86
DATE T.D. REACHED: 10-21-86
COMPLETION DATE (Ready to produce): N/A

15. TOTAL DEPTH
Measured: 4387.5'
True Vertical:

16. DIRECTIONALLY DRILLED INTERVALS: N/A

17. PLUGBACK TOTAL DEPTH
Measured: N/A
True Vertical:

18. SURVEYED INTERVALS: None

19. ELEVATION: ESTIMATED (X) FINAL ( ) 5835'
REFERENCE DATUM: GR ( ) RKB ( ) DF ( ) MSL ( ) MLW ( ) CASINGHEAD FLANGE ( ) OTHER ( )

20. DRILLING MEDIA: AIR ( ) WATER ( ) MUD ( ) FOAM ( ) OTHER (X) Temperature
List Characteristics:

21. CORE SIZE AND INTERVALS: 0-475' casing 4.5"
475'-4387.5' HQ 2.5"

22. LOG TYPE & INTERVALS: Dresser logs in order. Induction-Sp/Density Nuetron/Acoustic Fraclog/ X-Y Caliper/Temp (all to TD).

24. CASING RECORD

Size	Weight	Grade	Collars & Threads	Depths Set Top	Depths Set Shoe	Hole Size	Cementing Record (slurry volume)
4.5"	10.7#	A-53	Diamond Drill Flush Joint 3 Threads In	Surf.	475'	7-7/8"	1709 gals.

25. LINER RECORD

Size	Weight	Grade	Collars & Threads	Top	Bottom	Perforated Intervals	Cementing Record (slurry volume)

26. TUBING RECORD

Size	Weight	Grade	Depth Set	Packer Depth
1.9" O.D. 1.516" ID	2.9#/ft	J-55	4387.5'	

27. CEMENT SQUEEZE, ACID, FRACTURE, ETC. (detail type, amount, intervals operated)
Filled hole with Shur-gel (7200 gals.)

28. PERFORATION RECORD

Type	Total No.	Density (No./ft)	Size	Intervals

29. ATTACHMENTS & PREVIOUS SUBMITTALS: List all reports, surveys, tests and logs, not listed in Item 22, which have resulted from drilling and completion operations. List relevant previously furnished data with date of submittal referenced.

30. WELL STATUS: PRODUCING ( ) SHUT-IN ( ) SUSPENDED ( ) INJECTION ( ) DISPOSAL ( ) HEAT EXCHANGE ( ) ABANDONED (X) WATER SUPPLY ( ) OTHER

31. DO YOU CONSIDER THE WELL TO BE COMMERCIAL? EXPLAIN:
No

32. I hereby certify the information on this report and the attached information is complete and accurate according to the best of my knowledge.

SIGNED: Michael J. Lade TITLE Senior Environmental Coordinator DATE 11-26-86

This report is required by law (30 U.S.C. 1023); regulations: 30 CFR 270.37, 30 CFR 270.71; Federal Geothermal Lease Terms and Stipulations and other regulatory requirements. Failure to report in a timely prescribed manner can result in shutting down operations, suspension and or recommendation of cancellation of lease (30 U.S.C. 1011, 30 CFR 270.80, 43 CFR 3244.31. The United States Criminal Code (18 U.S.C. 1001) makes it a criminal offense to make a willfully false statement or representation to any Department or Agency of the United States as to any matter within its jurisdiction.

Form: USGS 9-1958

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY, CONSERVATION DIVISION

GEOTHERMAL SUNDRY NOTICE

The U.S. Geological Survey requests this form or other Supervisor approved form to be prepared and filed in triplicate with requisite attachments with the Supervisor. The Supervisor must approve this permit prior to any lease operations.

1a. WELL TYPE: PRODUCTION ( ) INJECTION ( ) HEAT EXCHANGE ( ) OBSERVATION (X) OTHER ( )

1b. WELL STATUS:
Permanent Abandonment

2. NAME OF LESSEE/OPERATOR
GEO Newberry Crater, Inc.

3. ADDRESS OF LESSEE/OPERATOR
61419 S. Highway 97, Suite A, Bend, OR 97702

13. LOCATION OF WELL OR FACILITY
4100' N and 500' E of SW corner of S24, T20S, R12E

4. LEASE NO.
OR 12004

5. SURFACE MANAGER: BLM ( ) FS ( ) Other ( )

6. UNIT AGREEMENT NAME
Newberry Volcano Fl

7. WELL NO.
N-3

8. PERMIT NO.
OR92086DNB

9. FIELD OR AREA
Newberry Volcano

10. SEC. T., R., B.& M.
S24, T20S, R12E

11. COUNTY
Deschutes

12. STATE
Oregon

14. TYPE OF WORK

CHANGE PLANS	( )	CONVERT TO INJECTION	( )	PULL OR ALTER CASING	( )
SITE AND ROAD CONSTRUCTION	( )	FRACTURE TEST	( )	MULTIPLE COMPLETE	( )
CONSTRUCT NEW PRODUCTION FACILITIES	( )	SHOOT OR ACIDIZE	( )	ABANDON	XX
ALTER EXISTING PRODUCTION FACILITIES	( )	REPAIR WELL	( )	OTHER	( )

15. DESCRIBE PROPOSED OPERATIONS (Use this space for well activities only. See instructions for current well conditions on reverse)

Proposed operations for permanently abandoning GEO N-3 include the following:

1. Separate 1.9" O.D. tubing (J-55) from 4" LP Flange by cutting with torch.
2. Remove 7-1/16 x 4-1/2" HW well head, 2" Ball valves, and 4" LP Flange from 4-1/2" HW regular casing.
3. Cement from surface 4-1/2" HW casing to a minimum depth of 15 meters (50 feet) measured from 2 meters (6 feet) below ground level with ASTM Type 1 and 11 Portland Cement.
4. Cap casing by welding steel plate on stub.
5. Remove cellar cribbing.
6. Backfill cellar and restore surface area as specified by USFS.

16. DESCRIBE PROPOSED OPERATIONS (Use this space for all activities other than well work)

(Use reverse side if needed)

17. I hereby certify that the foregoing is true and correct

SIGNED Jody Sherman TITLE Environmental Coordinator DATE 7/7/87

(This space for Federal use)

APPROVED BY _____ TITLE _____ DATE _____

CONDITIONS OF APPROVAL, IF ANY:

This permit is required by Law (30 U.S.C. 1023); regulations: 30 CFR 270.34, 30 CFR 270.35, 30 CFR 270.48, 30 CFR 270.71-1, 30 CFR 270.72; Federal Geothermal Lease Terms and Stipulations and other regulatory requirements. The United States Criminal Code (18 U.S.C. 1001) makes it a criminal offense to make a willfully false statement or representation to any Department or Agency of the United States as to any matter within its jurisdiction.

Form: USGS 9-1960

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY, CONSERVATION DIVISION

GEOTHERMAL WELL COMPLETION REPORT

The U.S. Geological Survey requires this form or other Supervisor approved form to be prepared and filed in duplicate with requisite attachments with the Supervisor within 30 days after completion of permitted operations.

RECEIVED
DEC 1-5 1987
OREGON STATE OFFICE
BUREAU OF LAND MANAGEMENT

1a. WELL TYPE: PRODUCTION ( ) INJECTION ( ) DISPOSAL ( ) WATER SUPPLY ( ) OBSERVATION (X)
COLD ( ) HEAT EXCHANGE ( ) OTHER ( )

1b. COMPLETION: NEW (X) WORKOVER ( ) DEEPENED ( ) PLUGBACK ( ) REDRILL ( )
RECOMPLETED ( ) DRILLED & ABANDONED ( ) OTHER ( )

2. NAME OF LESSEE/OPERATOR
GEO-Newberry Crater, Inc.

3. ADDRESS OF LESSEE/OPERATOR
61419 South Highway 97, Suite A, Bend, OR 97702

4. LOCATION OF WELL
At Surface: 4100'N & 500'E of SW Corner of S24, T20S, R12E
At Top of Production Zone:
At Total Depth:

5. FEDERAL LEASE NUMBER: SLM (X) FS ( ) Other ( )

6. UNIT AGREEMENT NAME
Newberry Flank

7. WELL NO.: GEO N-3

8. PERMIT NO.: OR 92086DNB-C

9. FIELD OR AREA
Newberry Crater

10. SEC., T., R., B. & M.
S24, T20S, R12E

11. COUNTY
Deschutes

12. STATE
OR

13. SPUD DATE: 6-2-86 DATE T.D. REACHED: 7-29-86

14. COMPLETION DATE (Ready to produce):
N/A

15. DIRECTIONALLY DRILLED INTERVALS
N/A

16. SURVEYED INTERVALS
None

17. CASING AND CEMENTING INTERVALS
0-454' 4½" casing
454'-1702' HQ 2.5"
1702'-4002' NQ 1.785"

18. TOTAL DEPTH
Measured: 4002' True Vertical: Not surveyed

19. PLUGBACK TOTAL DEPTH
Measured: N/A True Vertical:

20. ELEVATION: ESTIMATED (X) FINAL ( ) 5750'
REFERENCE DATUM: GR ( ) MAT ( ) DF ( ) KB ( ) RT ( ) CASINGHEAD FLANGE ( ) OTHER ( )

21. DRILLING MEDIA: AIR ( ) WATER ( ) MUD ( ) FOAM ( ) OTHER (X) Temperature
List Characteristics:

22. LOG TYPE & INTERVALS Logs (Dresser) in order. Temp/Caliper/Acoustic Fraclog/Nuetron (all to TD)/Gamma Density (to 1700' i.e. bottom of stuck HQ rods)

24. CASING RECORD

Size	Weight	Grade	Collars & Threads	Depths Set Top	Depths Set Bottom	Hole Size	Cementing Record (slurry volume)
4.5"	10.7#	A-53	Diamond Drill Flush Joint 3 Threads In	Surf.	454'	5-5/8"	25 cu. ft.

25. LINER RECORD

Size	Weight	Grade	Collars & Threads	Top	Bottom	Perforated Intervals	Cementing Record (slurry volume)

26. TUBING RECORD

Size	Weight	Grade	Depth Set	Packer Depth
1.9" O.D. 1.516" I.D.	2.9#/ft	J-55	4002'	

27. CEMENT SQUEEZE, ACID, FRACTURE, ETC. (detail type, amount, intervals)
Filled hole with abandonment mud.

28. PERFORATION RECORD

Type	Total No.	Density (No./ft)	Size	Intervals

29. ATTACHMENTS & PREVIOUS SUBMITTALS: List all reports, surveys, tests and logs, not listed in item 23, which have resulted from drilling and completion operations. List relevant previously furnished data with date of submittal referenced.

30. WELL STATUS: PRODUCING ( ) SHUT-IN ( ) SUSPENDED ( ) INJECTION ( ) DISPOSAL ( ) HEAT EXCHANGE ( ) ABANDONED (X) WATER SUPPLY ( ) OTHER

31. DO YOU CONSIDER THE WELL TO BE COMMERCIAL? No EXPLAIN:

32. I hereby certify the information on this report and the attached information is complete and accurate according to the best of my knowledge.

SIGNED: Victor J. Dale TITLE Senior Environmental Coordinator DATE 11-26-86

This report is required by law (30 U.S.C. 1023); regulations: 30 CFR 270.37, 30 CFR 270.73; Federal Geothermal Lease Terms and Stipulations and other regulatory requirements. Failure to report in a timely prescribed manner can result in shutting down operations, suspension and or recommendation of cancellation of lease (30 U.S.C. 1011, 30 CFR 270.66, 43 CFR 3244.1). The United States Criminal Code (18 U.S.C. 1001) makes it a criminal offense to make a willfully false statement or representation to any Department or Agency of the United States as to any matter within its jurisdiction.

MAIL ME DOE3401 AR "GEO DATA"

MEMO TO: SUE PRESTWICH

FROM: MIKE WRIGHT

SUBJECT: MISSING GEO DATA ON CASCADES PROGRAM

DATE: 20 NOV 86

The following list shows the data that we have received and that which is still missing from GEO Operator on the Cascades Deep Geothermal Gradient Drilling program. The contract calls for all items of data except those that require extended study to be delivered to UURI for public dissemination within one month after the drilling ends. As you can see, we lack most of the data for N-3, and the drilling stopped on 1 Aug 86. GEO was also quite late on the delivery of data for N-1 last year, and you can see from the chart that some of this data is still not delivered. Last year they informally asked for extra time to allow analysis and writing of a publication so that they could not be scooped in print. There is probably some of the same motivation this year, although I know they have been busy, too. I have had about a dozen calls in the past month asking when we will make a data release, and it is clear that some people are becoming a bit impatient.

ITEM (see Note 1)	N-1	N-3
Plug + abandonment plan	D	N
1. Core Samples (see Note 2)	D	D
2. Results of age dating	N D	N
3. Results of petrographic studies	N D	N
4. Drilling records (see Note 3)	~~D~~ N no driller's log	~~N~~ D
5. Temperature during drilling	D	~~N~~ D
6. Hydraulic head data	D	~~N~~ D
7. Results of analysis of drill fluids	~~N~~ D	N
8. Geophysical well logs (see Note 4)	D	~~N~~ D
9. Detailed mercury survey	~~N~~ D	N
10. Splits of mercury survey samples ?	N	N
11. Photographs of core	D	D
12. Schematic of hole completion	N	D

D = Delivered N = Not Delivered to Date

required? → 13. lithologic log by well site Geologist(s) D N

Note 1. The contract broadly calls for all of the data and information generated by this project to be delivered to DOE, so a statement to that effect in any letter or call to GEO would be in order. They may have some items beyond what is on this list.

Note 2. GEO has retained some of the core samples which were unsplit. They have used these for their own studies in which unsplit core samples are preferable. They say that these samples are available for others to use. We have noted the intervals

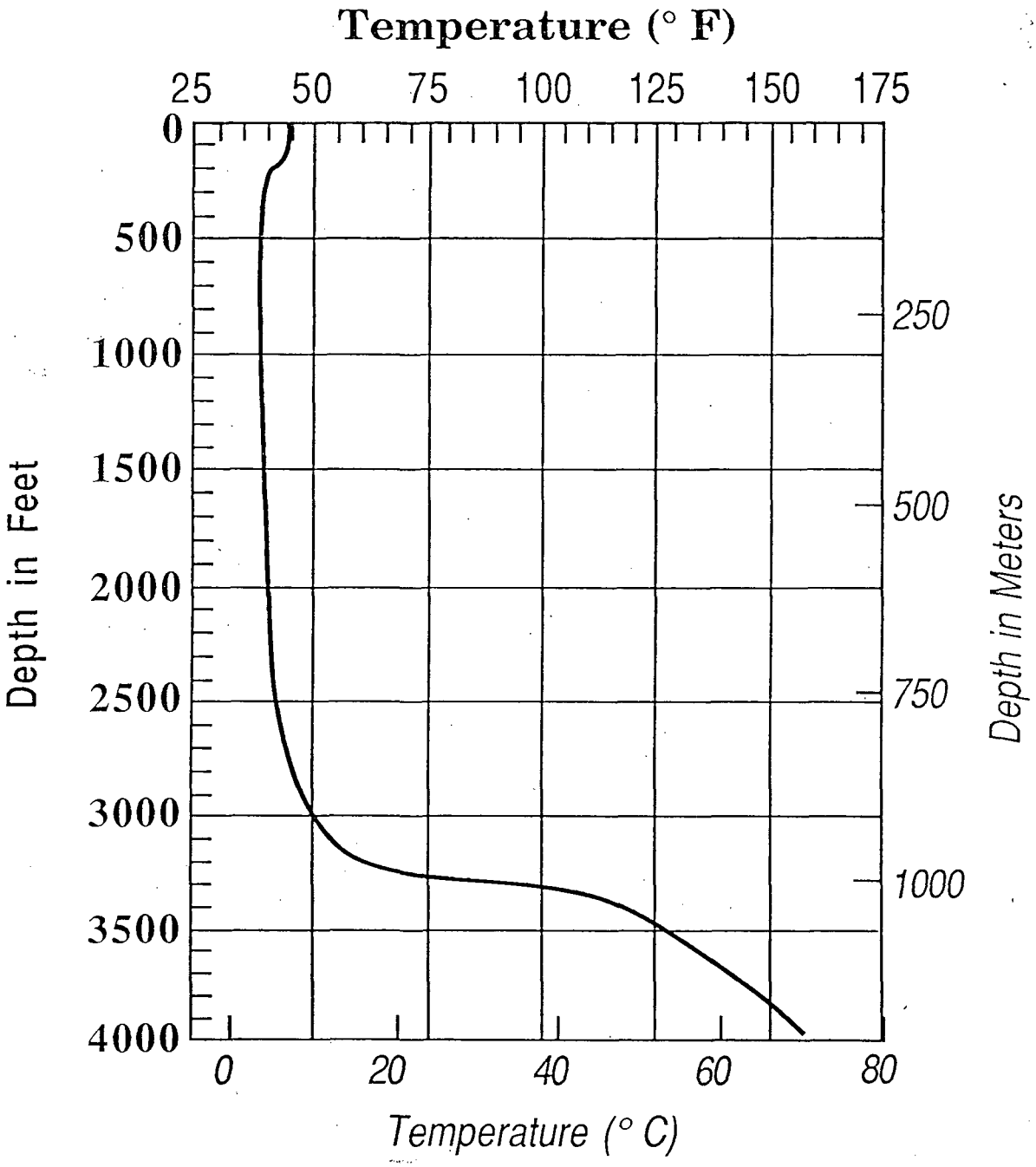
they have retained. Otherwise, we have a complete split of the core at UURI.

Note 3. They have not delivered all of the information they said in their proposal that the drilling record would contain. We have no information on lost circulation amounts, times depths, etc nor the location of water entries. I do not know whether they have these data and have not sent them or whether they did not collect some of these parameters.

Note 4. Chan told me that they had digital tapes of the Dresser logs for N-1, but they did not deliver these to me or to Rocky Mountain Well Log. If digital information exists, it would surely be worthwhile to have in the public domain.

.S
.END

TEMPERATURE - DEPTH LOG
GEO N-1



CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

STATUS OF GEO-NEWBERRY N-3

Spud Date	6/2/86
Expected Completion (4000')	8/1-4/86
Drilling Contractor	Tonto
Core Recovery	50 - 95%
Planned Completion	1-1/2" Iron Pipe
Geophysical Well Logs Planned	Temperature, Resistivity, Caliper SP, Sonic, Gamma-Ray, Induction, Fraclog

CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

STATUS OF THERMAL POWER CTGH-1

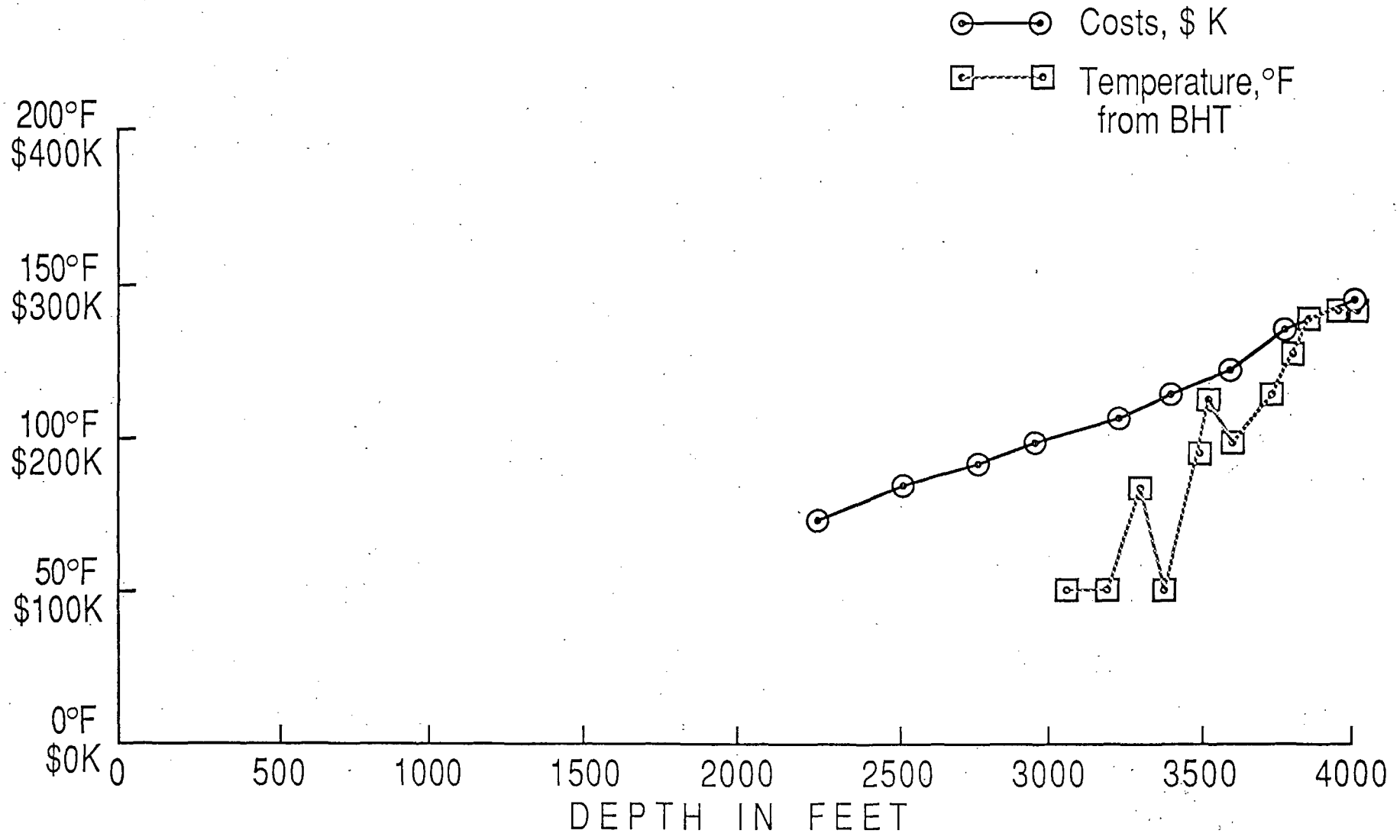
Spud Date	6/8/86
Expected Completion	8/12-16/86
Drilling Contractor	Boyles Brothers
Core Recovery	90 - 100%
Planned Completion	Iron Pipe
Geophysical Well Logs Planned	Temperature, Resistivity, Caliper, SP, Sonic, Gamma-Ray, Density

CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

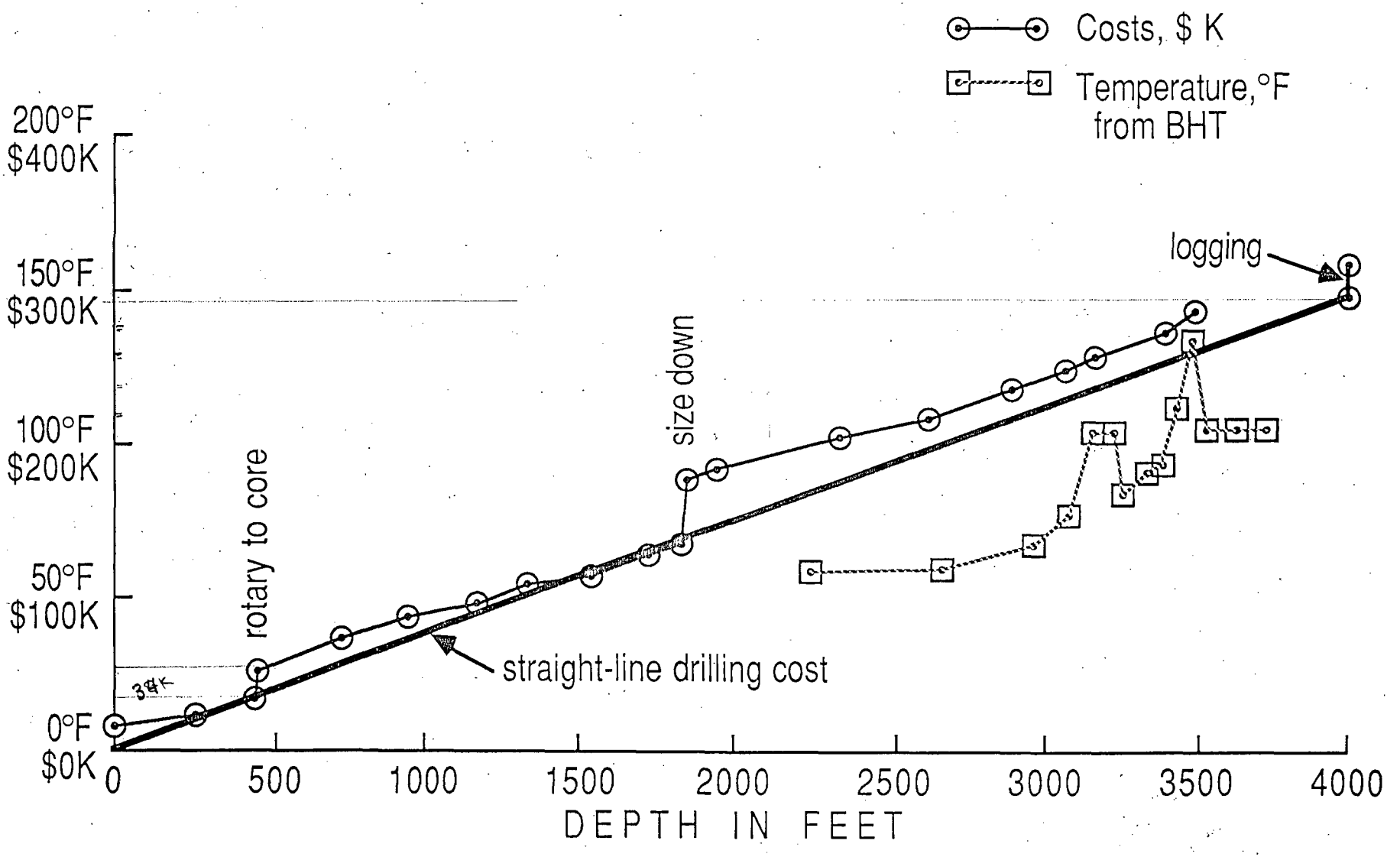
STATUS OF GEO-NEWBERRY N-3

Spud Date	6/2/86
Expected Completion (4000')	8/1-4/86
Drilling Contractor	Tonto
Core Recovery	50 - 95%
Planned Completion	1-1/2" Iron Pipe
Geophysical Well Logs Planned	Temperature, Resistivity, Caliper SP, Sonic, Gamma-Ray, Induction, Fraclog

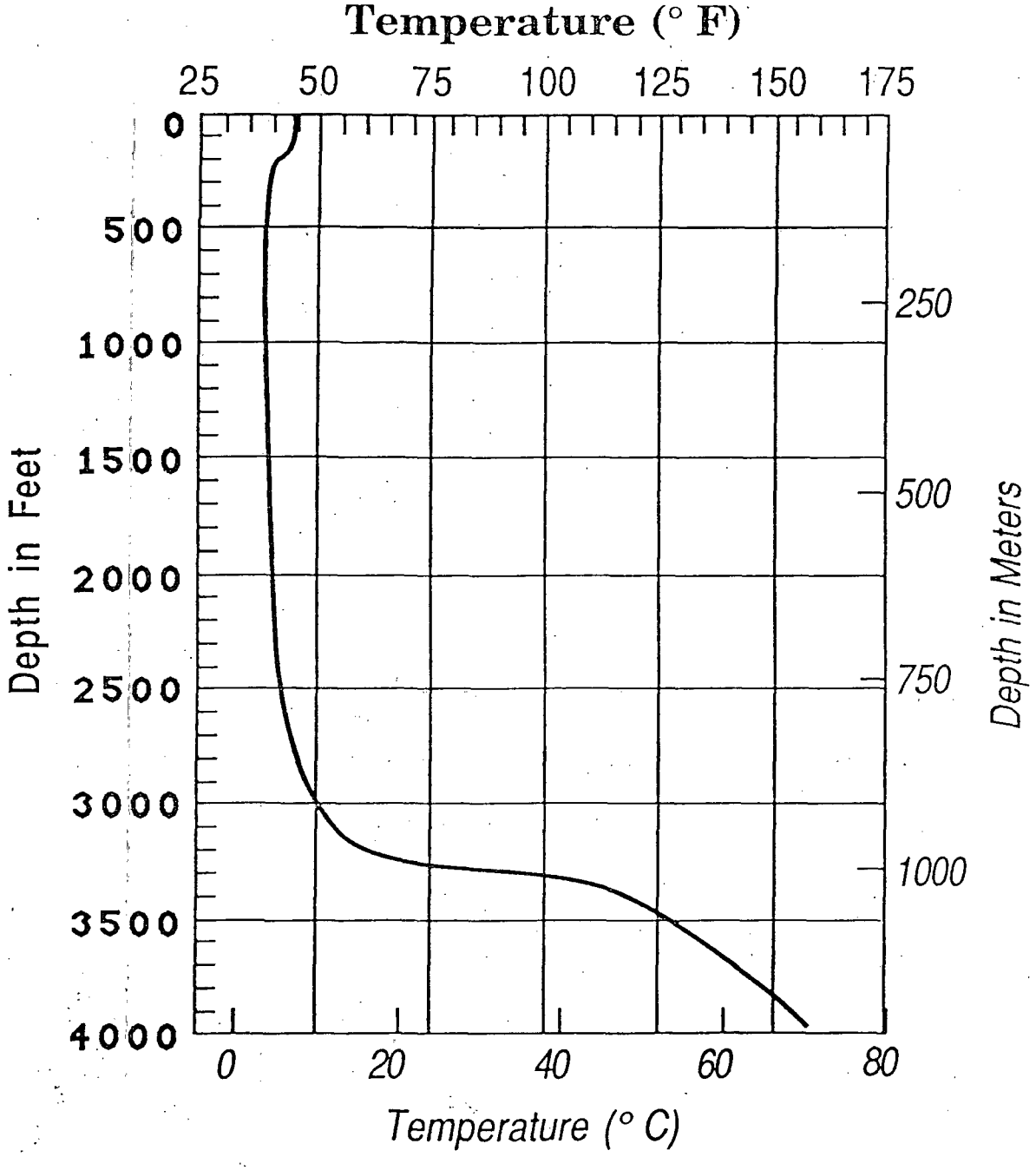
GEO-NEWBERRY COREHOLE N-3



GEO-NEWBERRY COREHOLE N-1



TEMPERATURE - DEPTH LOG
GEO N-1



CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

GEOPHYSICAL WELL LOGS

		GEO N-1	GEO N-3	Thrud CTGH-1	CECI M-2I-11A
(1)	Temperature	X	X	X	–
(2)	Caliper	X	X	4100-4800	–
(3)	Gamma Ray	X	X	X	–
(6)	Spontaneous Potential	X	–	4200-4,798	–
(7)	Resistivity	X	–	4200-4799	–
(10)	Induction	X	–	–	–
(11)	Acoustic	X	X	4225-4425	–
(12)	Acoustic Floolog	X	X	–	–
(4)	Neutron	–	–	X	–
(5)	Gamma-Gama Density	–	–	775-900	–
(8)	Induced Polarization	–	–	4200-4799	–
(9)	Lateralog	–	–	4200-4798	

X logged 0-TD
– not logged

DEPARTMENT OF ENERGY
CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

OBJECTIVE:

Sponsor research to characterize the deep hydrothermal regime of the Cascades in order to define its geothermal potential.

PROGRAM MANAGEMENT:

DOE/Idaho Operations Office

TECHNICAL COORDINATION:

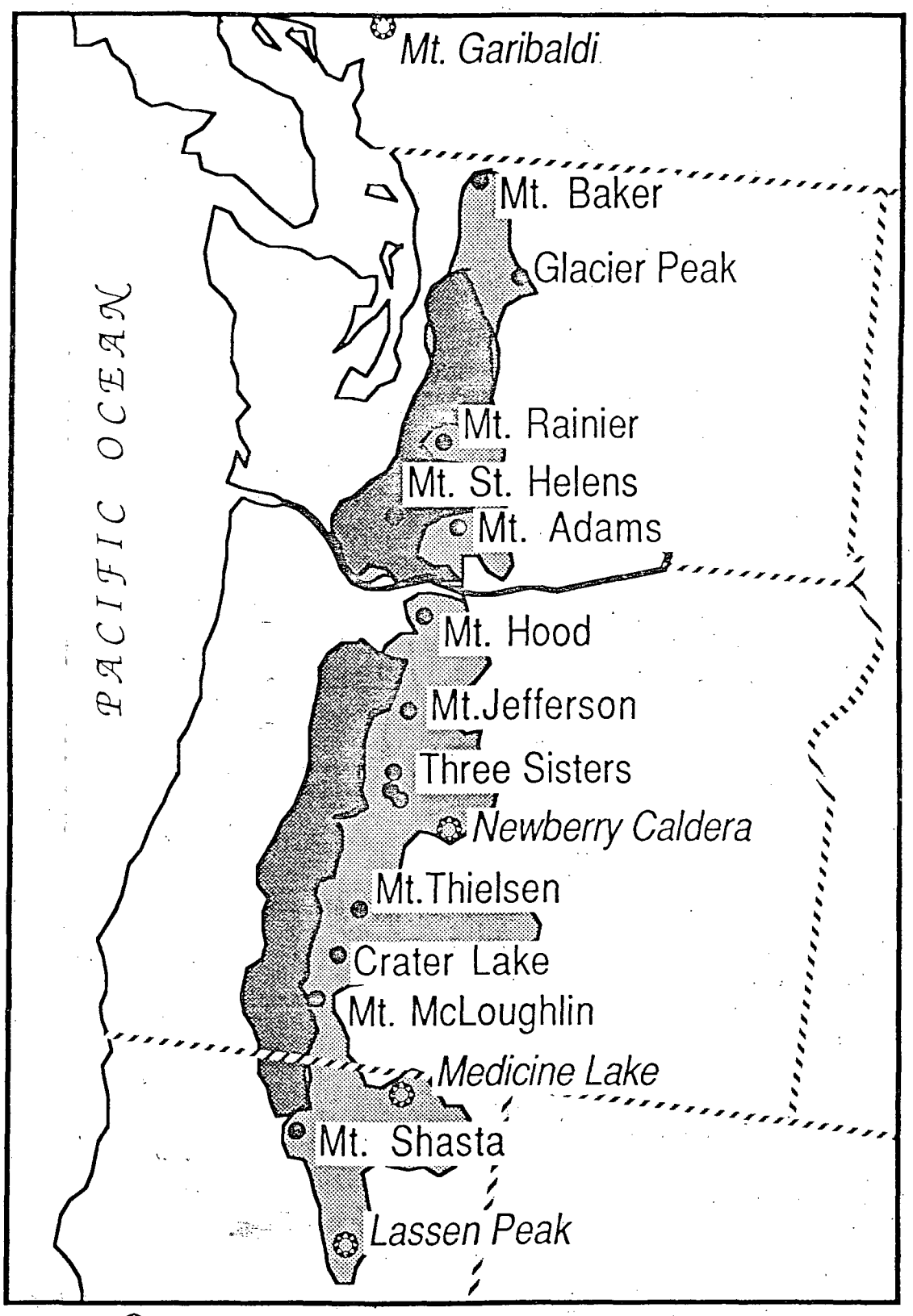
University of Utah Research Institute

MECHANISM:

Solicitations for Cost-Shared Drilling

Action – Quarterly Letter
– Higlights from headquarters
–

Next Meeting Thurs. May 19th.



High Temperature Hydrothermal System

International financing in order of day for Geoth in US

Successful People

1) Do or Die
2) Good cash flow contracts (motivation)
3) Unconventional (not utility mental)
4) Clear decision authority
5) specialists (consider themselves such)
   - it ~~seems~~ seems to work
   - geoth is opt. revenue & uptime } ?
6) bypass capability
7) instead of spare parts they have alliances with suppliers for quick service.

Considering EPRI - GRC session or conference

Utility is like marriage - 30 yr contract with temp. withdrawals for below peak load.

8) Autonomous working groups, but secure & obvious lineage (financial)

John says Wayne P. is inspired player in game!

CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

PROGRAM ELEMENTS

Thermal Gradient Drilling

Data Acquisition

- Lithology
- Geophysical Well Logs
- Hydrology
- Surface Studies

Data Integration and Interpretation

Technology Transfer

- Open File Release of Data and Core
- Case Studies

Johns Talk

Technical side of effort is Johns

- Get copy of report

New Info

- Bonneville has 50K to encourage interest in other agencies
  - most active role right now
  (USFS, ORGS, etc)
- Data Base - PC - Mike has.
  - expanded geothermal Data Base.
  - lease data may be incorporated as well
    - Bowen may complement this with USGS data
- John's Tour
- Mission (CEC) is first domestic money in Geoth.
  - Draft in 6 to 8 weeks for visit stuff.

Next John will visit financial project

Johns thesis is on strategy to develop for market of geothermal in Oregon in 1990's. BPA will (might) distribute it.

CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

STATUS

First Solicitation (closing date 4-29-85)

GEO Operator Corp.

Two Coreholes at Newberry

N-1	4000 ft. (public data)
N-3	4002 ft.

Thermal Power Company

One Corehole near Mt. Jefferson

CTGH-1	4800 ft.

Blue Lake Geothermal

Proposer Unable to Arrange Financing
◊◊Project Cancelled◊◊

Second Solicitation (closing date 5-30-86)

California Energy Company, Inc.

One Corehole (MZI-11A) Now Drilling
Near Crater Lake (Mazama)

Some people will be harmed by Master Plan or Decoy.

(18 Util) WPAG western power agency group is afraid of BPA because of unpredictability
- (they are not interested in geothermal, but maybe they will be)

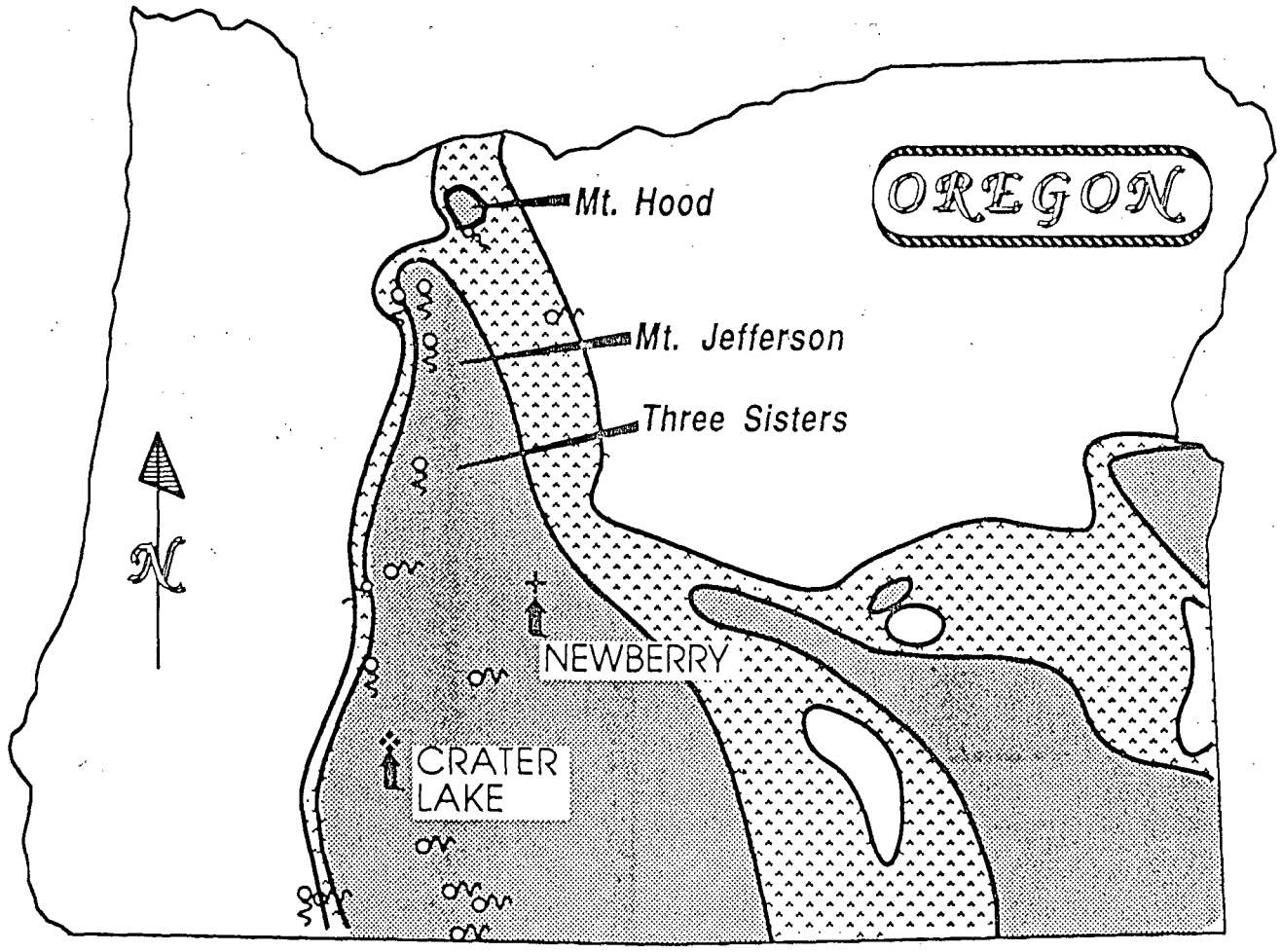
Western Power intertie (Idaho) is going to build an intertie (maybe)

Hydro is getting tough in Oregon - no killing any more fish - curtail Hydro.

↑

Supposedly these are all good for geothermal
Geoth is schedulable renewable resource

I must communicate to EGG + DOE + MIKE



Priest et al., 1983

100 mW/m ^{2}

80 mW/m ^{2}

Dougs Talk

Hyrnego - power over @ NW
shortage in Cal
Formed intertie + Transmission to Cal.
up to 4 to 8000 megawatts

BPA has lots of power - BC too all want to sell to Cal.

Bearing to Geothermal is preference for renewable

Now Cal got hold of the draft (Miller) + doesn't like it

- Now Plan for Geothermal is in effect

★ Want Critique on Plan by September
George will be in touch to get it done.

Future - Utility Deregulation
Utah - Pacific Merger - Pacific is dereg, biggest tele since Ma Bell.
- Will be competitor of Intertie

CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

SCIENTIFIC STUDIES

NEWBERRY

- Heat Flow - GEO and Southern Methodist
- Downhole Hg - GEO
- Alteration - USGS
- Volcanic Stratigraphy - U of Wyoming / NSF
- Correlation of Electric Logs with Alteration - UURI
- Analysis of Well Logs - UURI

CLAKAMAS

- Heat Flow - Southern Methodist
- Alteration - USGS
- Volcanic Stratigraphy - DOGAMI
- Analysis of Well Logs - UURI

MAZAMA

- Heat Flow - Southern Methodist
- Alteration - USGS
- Volcanic Stratigraphy - UURI
- Analysis of Well Logs - UURI

Drilling GEO permits – in Appeal (then to Federal Court)
- Burden of proof is on Sierra Club.
Lefleur introduced himself as John Muir in a meeting!

MOU almost signed - waiting for Forest Service

- Fed Bill in some house under consideration - to extend leases
- a problem is that the Parks Protection Groups connected to Boyd on committee & writing bill - other guy wanting bill is Nevada, Pro-Geothermal.

KGRA - competative leasing under revision - haven't had a sale for ≤5 years. Is it cost effective

[redacted]

CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

OPPORTUNITIES

- Holes available for down-hole experiments for one year
- Core stored at UURI; available for study
- Geophysical well logs and other acquired data available for study
- Correlation of surface studies with down-hole data

Abandonment of SP Quartzo & Baker (Mr Adams)

planned - there will be ups for sail.

Mt Hood - Do we have cuttings

30 holes - 5 or so 5'000 ft.

USFS (Bob)

BPA $20,000 → USFS for education of FS & People

Workshop for FS, Sierra, etc.

→ ☆ UURI participate

— Send Newspapers to DOE IDO

Topics for GRC Meetings

- Bright Bush
- Klamath Falls
- Ed for Bureaucrats & Public groups
- Environmental (talk on low profile power plants)

CASCADES DEEP GEOTHERMAL GRADIENT DRILLING PROGRAM

STATUS

- **GEO Operator Corp.**

N-1	(4000')	Completed 10/20/85 Data and samples open filed by UURI Feb 86
N-3	(4000')	Spud 6/1/86 – update

- **Thermal Power Company**

Clackamas	(5000')	Spud 6/1/86 – updat

- **Blue Lake Geothermal**

Blue Lake	(4000')	Spud ?

- **New Solicitation: May 30, 1986**

Two additional holes anticipated

EPA Conf on Geoth in June in small city bought part of geysers

Doug - Eng. Future & Hay
Utility Advis Committee - EPRI
John - Generation Planning
New Charter
Geoth still good
Wind & Solar down

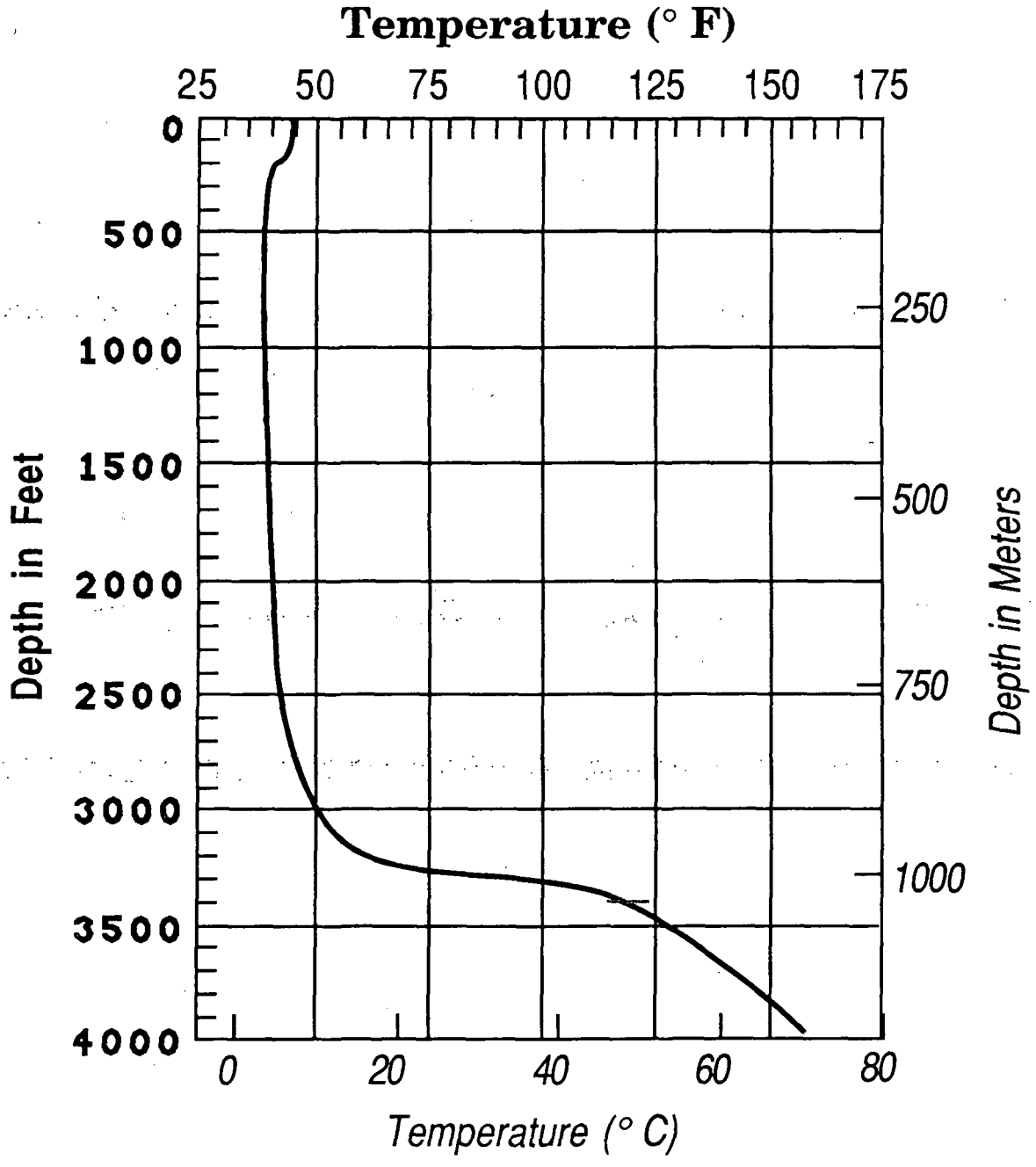
George: Eng for Geoth
Bobby - Advisor on leasable - Forest
Jack - BLM - geol.

- Dissemination through UURI - cascades
  - Press Releases
  - Where are newsletters
  - is there another way?
  - what is being done on corehole

ne - Release Weekly News

- maybe release through BPA
- Periodic Release of Glacier Peak Work

TEMPERATURE - DEPTH LOG
GEO N-1



3000 - 50

3400 - 166

GEO N-3 FINAL LOGS

Differential Temp. log 5"=100' (50-4002 ft)

Differential Temp. log 2"=100' (50-4002 ft)

Caliper log 2"=100' (1690-3999 ft)

Caliper log 5"=100' (1690-3999 ft)

Densilog Neutron Gamma Ray 2"=100' (50-1692 ft)

Densilog Neutron Gamma Ray 5"=100' (50-1692 ft)

Fraclog 5"=100' (1700-4001 ft) (w. caliper, neutron)

Neutron 2"=100' (50-4000 ft)

Neutron 5"=100' (50-4000 ft)

All Logs by Dresser Atlas Co.; 7-28-86 and 7-29-86

From Rocky Mountain well log

WELL LOGS TRANSMITTED

N-3

GEO ~~N-1~~ Sec. 24, T20S,R12E Deschutes Co., Oregon

Operator: GEO-Newberry Crater, Inc.
Logs by: Dresser Atlas; July 28, 29, 1986

Differential Temperature; 50-4002 ft; 5" = 100'; 2" = 100 ft

Caliper log; 1690-3999 ft; 5" = 100'; 2" = 100 ft

Densilog Neutron, Gamma Ray; 50-1692 ft; 5" = 100 ft; 2"= 100 ft

Fraclog; 1700-4001 ft; 5" = 100 ft

Neutron; 50-4000 ft; 5" = 100 ft; 2" = 100 ft

CTGH-1 Sec. 28, T8S, R8E Mrion Co., Oregon

Operator: Thermal Power Co.
Logs by: Colorado Well Logging, Inc.

Logs of June 13, 1986

Temperature and fluid resistivity; 16-514 ft

SP and 16" and 64" resistivity; 35-516 ft

Natural gamma, neutron, guard resistivity; 20-516 ft

Caliper and gamma-gamma density; 0-510 ft

Logs of September 3-5, 1986

Density; 4200-4295 ft

Temperature and fluid resistivity; 0-4785 ft

Natural gamma, neutron; 0-4800 ft

Sonic velocity; 4225-4425 ft

SP, 16" and 64" resistivity; 4200-4799 ft

```
      Set   Items   Description
      ---   -----   -----------
Processing
Processing
Processing
      S1    12037   ALTERATION
      S2     4915   RESISTIVITY
      S3     6476   CONDUCTIVITY
      S4    30333   VOLCANIC
      S5   232571   ROCK? ?
      S6    14314   VOLCANIC(W)ROCK? ?
      S7        3   ALTERATION AND (RESISTIVITY OR CONDUCTIVITY) AND
                    VOLCANIC()ROCK? ?
?t 7/5/all


 7/5/1
1238714   84-35448
  Structural control of the Baltazor Hot Springs geothermal system,
Humboldt County, Nevada
  Hulen, J. B.
  Univ. Utah Res. Inst., Earth Sci. Lab., Salt Lake City, UT, USA
  Geothermal resources; energy on tap!
  Hunt, H. H.(chairperson)
  Eugene Water and Electr. Board, Eugene, OR, USA
  Geothermal Resources Council, 1983 annual meeting, Portland, OR, United
States, Oct. 24-27, 1983
  Transactions - Geothermal Resources Council 7, 157-162p., 1983
  Country of Publ.: United States
  ISSN: 0193-5933
  17 REFS.
  Subfile: B
  Doc Type: SERIAL; CONFERENCE PUBLICATION  Bibliographic Level: ANALYTIC
  Languages: English
  sketch map, sect. block diag.
  Descriptors: *Nevada ; economic geology ; geothermal energy; Humboldt
County; United States; Baltazor Hot Springs KGRA; structural controls;
 siliceous sinter; chemically precipitated sediments; reservoir rocks;
 exploration; drilling; faults; cartography; resistivity; Miocene; Neogen;
 Tertiary; volcanic rocks; Basin and Range Province; Pueblo Mountains;
 hydrothermal alteration; metasomatism
  Section Headings: 29 (ECONOMIC GEOLOGY, ENERGY SOURCES)

 7/5/2
950129   79-36481
  Results of an experimental drill hole at the summit of Kilauea Volcano,
Hawaii
  Keller, G. V.; Grose, L. T.; Murray, J. C.; Skokan, C. K.
  Colo. Sch. Mines, Dep. Geophys., Golden, Colo., USA; Tex. Gulf, USA
  J. Volcanol. Geotherm. Res. 5: 3-4, 345-385p., 1979
  Country of Publ.: Netherlands
  ISSN: 0377-0273
  CODEN: JVGRDG  49 REFS.
  Subfile: B
  Doc Type: SERIAL  Bibliographic Level: ANALYTIC
  Languages: English
  illus., sketch maps
  Latitude: N191500; N192500  Longitude: W1550500; W1552000
  Descriptors: *Hawaii; *volcanology; *well-logging; *igneous rocks ;
economic geology; volcanoes; applications; basalt family ; geothermal
```

$27.05

[illegible]

energy; Kilauea; olivine basalt; Pacific Ocean; United States; borehole; thermal waters; exploration; geothermal systems; convection; magma chambers; petrography; cores; temperature; thermal conductivity; heat transfer; thermal alteration; data; volcanic rocks
Section Headings: 29 (ECONOMIC GEOLOGY, ENERGY SOURCES)

7/5/3
482159 68-07145-N
Electric and caliper logs as lithologic indicators in volcanic rocks, Nevada Test Site
Snyder, R. P.
in Nevada Test Site
Geol. Soc. America Mem. 110 p. 117-124, illus., 1968 QE 137 G46
Subfile: N
Electric logs are used on Pahute Mesa at the Nevada Test Site for preliminary identification of volcanic rock units penetrated by drill holes. Induced and produced water in the drill holes have essentially the same resistivity, so the spontaneous potential curve is negated, and the resistivity curves measure pore space of the rock. Degree of welding or amount and kind of alteration affect pore space and, therefore, resistivity. In general, resistivities are lowest in bedded tuffs and increase proportional to welding in ash-flow tuffs, and are greatest in rhyolitic lava flows. Caliper logs locate lithologic zones which tend to slough or cave. These zones are poorly indurated ash-falls tuffs, vitric and highly fractured ash-flow tuffs and rhyolites. Zeolitized ash-flow and ash-fall tuffs and unfractured rhyolites are competent.
Descriptors: *Engineering geology; *Nevada; *Igneous rocks; *Well logging ; Materials; properties; Volcanics; Geophysical surveys; Caliper; Electrical ; Pahute Mesa; volcanic rocks; Engineering properties; Pahute Mesa; electric and caliper logging; Interpretation
?ss electrical()propert? and igneous()rock? ?

Processing
{_~rProcessing
Processing
Processing
Processing
S8 13386 ELECTRICAL
S9 61610 PROPERT?
S10 1608 ELECTRICAL(W)PROPERT?
S11 100634 IGNEOUS
S12 232571 ROCK? ?
S13 69408 IGNEOUS(W)ROCK? ?
S14 174 ELECTRICAL()PROPERT? AND IGNEOUS()ROCK? ?
?ss s (s14 and s1) not s7

>>>Invalid character in above command (line noise?)
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?ss c (14 and 1) not 7

174 14
12037 1
3 7
S15 3 (14 AND 1) NOT 7
?t 15/5/all

15/5/1
733584 74-38731
Magnetic properties of DSDP basalts
Lowrie, W.

in Deep Sea Drilling Project; Properties of Igneous and Metamorphic Rocks of the Oceanic Crust; magnetic and electrical properties,
Eos (Am. Geophys. Union, Trans.) Vol. 54, No. 11, p. 1026-1027, illus., 1973
CODEN: EOSTAJ
Subfile: B
Doc Type: SERIAL
Languages: English
Descriptors: *Igneous rocks; *Ocean floors ; Basalt family; Petrology ; Basalt; deep sea; magnetic properties; remanent magnetism; Deep Sea Drilling Project; comparison; samples; dredged; stability; effects; oxidation; hydrothermal alteration; plate tectonics; viscous remanent magnetization; titanomagnetite; Curie temperature; variations
Section Headings: 18 (GEOPHYSICS, SOLID EARTH)

15/5/2
733581 74-38728
Maghemitization and alteration of Class I titanomagnetites in pillow lavas
Fink, L. Kenneth, Jr.; Harrison, C. G. A.
in Deep Sea Drilling Project; Properties of Igneous and Metamorphic Rocks of the Oceanic Crust; Magnetic and electrical properties,
Eos (Am. Geophys. Union, Trans.) Vol. 54, No. 11, p. 1024-1025, illus., 1973
CODEN: EOSTAJ
Subfile: B
Doc Type: SERIAL
Languages: English
Descriptors: *Igneous rocks; *Lava; *Minerals; *Ocean floors ; Basalt family; mid-ocean ridges; Properties; Oxides ; Basalt; submarine; petrology; magnetic properties; weathering; oxidation; hydrothermal alteration; relation; Deep Sea Drilling Project; pillow structures; maghemitization; ocean basins; Titanomagnetite; changes; temporal; spatial; Magnetic quiet zones
Section Headings: 18 (GEOPHYSICS, SOLID EARTH)

15/5/3
662930 73-02195
Precursors of the destruction of rock specimens
Tomashevskaya, I. S.; Khamidullin, Ya. N.
Phys. Solid Earth (Engl. Ed.) No. 5, p. 276-281, illus., 1972
CODEN: IPSEBQ
Subfile: B
Doc Type: SERIAL
Languages: English
Descriptors: *Deformation; *igneous rocks ; Experimental studies ; Compression; alteration; electrical properties; elastic properties; acoustical properties
Section Headings: 18 (GEOPHYSICS, SOLID EARTH)
?ss c 1 and (2 or 3) and 13

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        12032  1
         4915  2
         6476  3
        69408  13
S16        7  1 AND (2 OR 3) AND 13
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?c 16 not (15 or 7)

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           7  16
           3  15
           3  7
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S17 5 16 NOT (15 OR 7)
?t 17/5/all

17/5/1
1365276 86-18571
Use of multiple regression for petrophysical characterization of granites as a function of alteration
Agterberg, F. P.; Katsube, T. J.; Lew, S. N.
Geol. Surv. Can., Econ. Geol. and Miner. Div., Ottawa, ON, CAN
Current Research, Part B
Paper - Geological Survey of Canada 85-1B, 451-458p., 1985
Country of Publ.: Canada
ISSN: 0707-2996
CODEN: CGSPAV 11 REFS.
Subfile: B
Doc Type: SERIAL Bibliographic Level: ANALYTIC
Languages: English Summary Languages: French
illus., 3 tables, block diag.
Descriptors: *igneous rocks; *waste disposal ; granites; radioactive waste ; physical properties; feasibility studies; porosity; regression analysis; micropores; seepage; resistivity; alteration
Section Headings: 22 (ENGINEERING & ENVIRONMENTAL GEOLOGY)

17/5/2
837570 77-18468
Application des proprietes de resistivite des terrains d'alteration a la connaissance de la tectonique du massif de Saraya (Senegal oriental)
Application of resistivity properties of altered terrains to the study of the tectonics of the Saraya Massif, eastern Senegal
Dorbath, C.; Froidevaux, P.; Blot, A.; Carn, M.
Fr., Off. Rech. Sci. Tech. Outre-Mer, Cah., Ser. Geol. 7: 2, 111-123p., 1975
Country of Publ.: France
CODEN: CORGBM 9 REFS.
Subfile: B
Doc Type: SERIAL Bibliographic Level: ANALYTIC
Languages: French Summary Languages: English
illus., ; geophys. surv. maps
Descriptors: *Senegal; *geophysical surveys; *maps; *Precambrian ; electrical surveys; Africa ; east; Saraya; resistivity; ground; structur; massifs; igneous rocks; complexes; granite; dolerite; gabbro; Birrimian
Section Headings: 20 (GEOPHYSICS, APPLIED)

17/5/3
830794 77-09771
Area de reserva N o 3, zona Paramillos Norte, provincia de Mendoza
Reserve No. 3 area, Paramillos Norte Zone, Mendoza
Navarro, H.
Jornadas Geol. Argent., Actas 4, Tomo 3, 105-125p., 1972
Country of Publ.: Argentina
CODEN: AJOGBI 0 REFS.
Subfile: B
Doc Type: SERIAL Bibliographic Level: ANALYTIC
Languages: Spanish
illus., strat. col., geol. sketch maps
Descriptors: *mineral exploration; *Argentina; *mineral deposits; *genesis; *mineral resources; *igneous rocks; *Tertiary ; methods; processes; South America; areal geology; petrology ; geochemical method; geophysical methods; resistivity; sulfur; iron; Reserve No. 3; supergene processes; igneous processes; copper; deposits; exploration; economic

geology; stratigraphy; Mendozoa; Paramillos Norte; diorite; andesite; volcanic breccia; hydrothermal alteration; lithostratigraphy; faults
Section Headings: 13 (AREAL GEOLOGY, GENERAL)

17/5/4
491426 68-11897
Fizicheskiye svoystva i veshchestvennyy sostav magmaticheskikh obrazovaniy tsentral'noy chasti Gornogo Kryma
Physical properties and mineral composition of the magmatic formations of the central part of the Crimean mountains
Lebedev, T. S.; Orovetskiy, Yu. P.
Geofiz. Sb. (Akad. Nauk Ukr. SSR) No. 17, p. 62-80, illus. (incl. sketch map), 1966
Subfile: E
Doc Type: SERIAL
Languages: Russian
The mafic intrusions in the central part of the Crimean mountains (USSR), following the Krivoi Rog-Samsun abyssal fault zone, show a very wide range of variations in physical parameters. Density varies from 2.62 to 2.80 g per cm 3 , averaging 2.71. With rare exceptions magnetic susceptibility does not exceed a few tens of units; however, remanent magnetization varies within fairly wide limits, from a few units to 45,000 X 10 -6 cgsm. Specific resistivity varies depending on the content and nature of the ore mineral inclusions and their degree of alteration. Dielectric permeability ranges from 6.5 to 25.2. Longitudinal wave velocities show a definite increase in average values from 3900 mps for silicic to 5600 mps for mafic rocks, and confirm the direct relationship between velocity and density and between velocity and grain size.
Descriptors: *USSR; *igneous rocks ; Petrology; Intrusive ; Crimea; Physical properties-mineral composition
Section Headings: 05 (PETROLOGY, IGNEOUS AND METAMORPHIC)

17/5/5
163622 49-03742-N
Geological and geophysical survey of fluorspar areas in Hardin County, Illinois
Currier, Louis Wade
U.S. Geol. Survey Bull. 942, ix 150 p., illus. incl. index, geol. maps, 1944
Subfile: N
Contains parts by L. W. Currier and M. K. Hubbert, which are cited individually.
Descriptors: *Carboniferous; *Illinois; *Devonian; *Faults and faulting; *Fluorite; *Folding; *Geologic formations; *lists; *sections; *tables; *Geologic history; *Geologic maps; *Geophysical investigations; *Hydrothermal alteration; *Igneous rocks; *Jointing; *Limestone; *Magmas and magmatic differentiation; *Mineral deposits; *origin; *Sandstones; *Sedimentary rocks; *Shale ; Economic geology; Historical geology; Physical geology; Physiographic geology ; Hardin County fluorspar areas; Hardin County; Colorado; faults; earth-resistivity method; Fluorspar areas; Hardin County fluorite areas; Illincis
?c (6 and 10) not (7 or 15 or 17)

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      14314  6
       1608  10
          3  7
          3  15
          5  17
S18      12  (6 AND 10) NOT (7 OR 15 OR 17)
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?t 18/5/all

18/5/1
1318443 85-54787
A percolation model of changes in the electrical conductivity of alkaline volcanic rocks of the Bohemian Massif
Lastovickova, M.; Kropacek, V.
Czech. Acad. Sci., Inst. Geophys., CSK
Geophysical Journal 8: 3, 435-442p., 1984
Country of Publ.: United States
ISSN: 0275-9128
CODEN: GJOUD0 11 REFS.
Subfile: B
Doc Type: SERIAL Bibliographic Level: ANALYTIC
Languages: English
2 tables
Descriptors: *igneous rocks; *Czechoslovakia; *titanium; *iron ; properties; petrology; geochemistry ; electrical properties; volcanic rocks; models; electrical conductivity; Bohemian Massif; Europe; alkalic composition; percolation
Section Headings: 17 (GEOPHYSICS, GENERAL)

18/5/2
1300543 85-29987
How radar can improve our knowledge of Mars
Schaber, G. G.
U. S. Geol. Surv., Flagstaff, AZ, USA
Joint European Geophysical Society/European Seismological Commission general assembly
Joint European Geophysical Society/European Seismological Commission general assembly, Leeds, United Kingdom, 1982
Eos, Transactions, American Geophysical Union 63: 51, 1323-1324p., 1982
Country of Publ.: United States
ISSN: 0096-3941
CODEN: EOSTAJ
Subfile: B
Doc Type: SERIAL; CONFERENCE PUBLICATION Bibliographic Level: ANALYTIC
Languages: English
Descriptors: *Mars ; geophysical surveys ; remote sensing; observation; radar methods; geophysical methods; topography; electrical properties; Chryse Basin; Syrtis Major; terrains; channels; Viking Program; imager; thermal properties; photogrammetry; volcanic rocks; textures
Section Headings: 04 (EXTRATERRESTRIAL GEOLOGY)

18/5/3
1245960 84-37933
Electrical properties of water- and steam-saturated zeolite
Olhoeft, G. R.
U. S. Geol. Surv., Denver, CO, USA
American Geophysical Union; 1983 Fall meeting
Anonymous
American Geophysical Union, Fall meeting, San Francisco, CA, United States, Dec. 5-9, 1983
Eos, Transactions, American Geophysical Union 64: 45, 692-693p., 1983
Country of Publ.: United States
ISSN: 0096-3941
CODEN: EOSTAJ
Subfile: B
Doc Type: SERIAL; CONFERENCE PUBLICATION Bibliographic Level: ANALYTIC
Languages: English
Descriptors: *geophysics ; experimental studies ; volcanic rocks; electrical properties; saturation; geothermal gradient; electrical

conductivity; zeolite group; framework silicates; silicates; geothermal energy; interpretation
Section Headings: 17 (GEOPHYSICS, GENERAL)

18/5/4
1223408 84-15056
Geoelectric structure of the Gila-San Francisco Wilderness Area, Graham and Greenlee counties, Arizona from audio-magnetotelluric data
Klein, D. P.; Baer, M. J.
U. S. Geol. Surv., Denver, CO, USA
Open-File Report (United States Geological Survey. 1978) 107p., 1983
Country of Publ.: United States
ISSN: 0196-1497
CODEN: XGROAG 29 REFS.
Subfile: B
Doc Type: SERIAL; REPORT Bibliographic Level: MONOGRAPHIC
Languages: English
Report No.: 83-0815
Availability: U. S. Geol. Surv., Open-File Serv. Sect., West. Distrib. Branch, Fed. Cent., Denver, CO, United States
illus., 3 tables, sects., sketch maps
Latitude: N325230; N330500 Longitude: W1091915; W1093400
Descriptors: *Arizona ; geophysical surveys ; magnetotelluric surveys; Graham County; Greenlee County; USGS; United States; Gila-San Francisco Wilderness Area; electrical properties; electromagnetic induction; audio-magnetotelluric methods; audiomagnetotelluric methods; faults; resistivity; volcanic rocks; mineral exploration
Section Headings: 20 (GEOPHYSICS, APPLIED)

18/5/5
1064067 81-49041
Seismic velocities and electrical resistivity of Recent volcanics and their dependence on porosity, temperature, and water saturation
Ibrahim, A. W.; Keller, G. V.
Univ. Alberta, Inst. Earth and Planet. Phys., Edmonton, AB, CAN; Colo. Sch. Mines, USA
Geophysics | 46: 10, 1415-1422p., 1981
Country of Publ.: United States
ISSN: 0016-8033
CODEN: GPYSA7 29 REFS.
Subfile: B
Doc Type: SERIAL Bibliographic Level: ANALYTIC
Languages: English
illus., 1 table
Descriptors: *igneous rocks; *seismology; *geophysics; *rock mechanics; *lava; *petroleum ; volcanic rocks; elastic waves; experimental studies; materials; properties ; physical properties; P-waves; petrophysics; reservoir properties; elastic properties; electrical properties; resistivity; porosity; temperature; pore water; velocity; saturated materials; Cenozoic; Phanerozoic; basalts; volcanic breccia; pyroclastic; clastic rocks; reservoir rocks; lava flows; Columbia Plateau; United States; New Mexico; Cascade Range; Western U.S.; materials, properties; data
Section Headings: 17 (GEOPHYSICS, GENERAL)

18/5/6
966470 80-07447
The electrical resistance of volcanic rocks in the southern part of a lava field on the Siberian Platform
Zyuzin, A. Ya.
Sov. Geol. Geophys. 19: 4, 110-112p., 1978

Country of Publ.: United States
CODEN: SGGEDF 3 REFS.
Subfile: B
Doc Type: SERIAL Bibliographic Level: ANALYTIC
Languages: English
illus., tables
Latitude: N550000; N720000 Longitude: E1260000; E0900000
Descriptors: *USSR; *igneous rocks ; geophysical surveys; volcanic rocks ; electrical surveys; basalt; basalt family; resistivity; lava flows; electrical properties; properties; Siberian Platform
Section Headings: 17 (GEOPHYSICS, GENERAL)

18/5/7
938929 79-22018
Svyaz' elektricheskogo soprotivleniya vulkanogennykh porod Ukrainy s ikh petrokhimicheskimi kharakteristikami
Relation of the electrical resistance of volcanogenic rocks of the Ukraine with their petrochemical characteristics
Parkhomenko, E. I.; Indutnyy, F. V.
Fizicheskiye svoystva gornykh porod i mineralov pri vysokikh davleniyakh i temperaturakh
Lyubimova, Ye. A.(EDITOR)
Publ: Izd. Nauka
188-196p., 1978
Country of Publ.: Union of Soviet Socialist Republics
2 REFS.
Subfile: B
Doc Type: BOOK Bibliographic Level: ANALYTIC
Languages: Russian
illus.
Latitude: N443000; N523000 Longitude: E0400000; E0220000
Descriptors: *igneous rocks; *USSR ; volcanic rocks; petrology ; electrical properties; deformation; electrical conductivity; properties; experimental studies; P-T conditions; Ukraine; geochemistry
Section Headings: 17 (GEOPHYSICS, GENERAL)

18/5/8
913418 78-43908
Dependence of velocity and resistivity of volcanic rocks on temperature and porosity
Ibrahim, A.
Colo. Sch. Mines, Golden, Colo., USA
Geothermal energy; a novelty becomes resource; transactions; Volume 2, Section 1
Combs, J.(chairperson)
Geothermal energy; a novelty becomes resource, Hilo, Hawaii, United States, July 25-27, 1978 GB 1199.5 G48
Publ: Geothermal Resour. Counc.
303-304p., 1978
Country of Publ.: United States
Subfile: B
Doc Type: BOOK; CONFERENCE PUBLICATION Bibliographic Level: ANALYTIC
Languages: English
illus.
Descriptors: *New Mexico; *rock mechanics; *California ; engineering geology; materials; properties ; igneous rocks; Sandoval County; volcanic rocks; elastic properties; P-waves; elastic waves; velocity; Cenozoic; Phanerozoic; experimental studies; temperature; porosity; electrical properties; resistivity; United States; Jemez Mountains; Columbia Platea; materials, properties
Section Headings: 22 (ENGINEERING & ENVIRONMENTAL GEOLOGY)

18/5/9
874517 78-05983
Dependence of the electrical properties of igneous rocks in the Tashkent seismic zone on moisture content, pressure and temperature
Bakiyev, M. Kh.; Bondarenko, A. T.; Bakiyev, M. Kh.
Acad. Sci. USSR, Dokl., Earth Sci. Sect. 222: 1-6, 18-20p., 1975
Country of Publ.: United States
CODEN: DKESA9 17 REFS.
Subfile: B
Doc Type: SERIAL Bibliographic Level: ANALYTIC
Languages: English
illus.
Latitude: N411600; N411600 Longitude: E0691300; E0691300
Descriptors: *USSR; *seismology; *igneous rocks ; earthquakes; properties ; electrical properties; prediction; variations; Tashkent; pressure; temperature; moisture; andesite; andesite-rhyolite family; diorite; diorite family; granodiorite; granite-granodiorite family; volcanic rocks; dacite
Section Headings: 19 (GEOPHYSICS, SEISMOLOGY)

18/5/10
704994 74-10111
Geoelectrical investigations near The Geysers geothermal area, California--Investigaciones geoelectricas cerca del area geotermica de Geysers, California [abstr.]
Stanley, William D.; Jackson, Dallas B.
Soc. Explor. Geophys., Annu. Int. Mtg. No. 43, p. 41-42 (Engl.), p. 42-43 (Span.), 1973
CODEN: SGAMB7
Subfile: B
Doc Type: SERIAL
Languages: English; Spanish
Asoc. Mex. Geofis. Explor. Mtg., No. 5,
Descriptors: *California; *Geophysical surveys; *geothermal energy; *Quaternary; *Sedimentary rocks ; Electrical surveys; United States; Properties ; north; Lake County; The Geysers; resistivity; correlatio; gravity surveys; anomalies; interpretation; heat flow; exploration; electrical properties; igneous rocks; volcanic; Clear Lake Volcanic Series; applications
Section Headings: 18 (GEOPHYSICS, SOLID EARTH)

18/5/11
435464 68-09230-G
RESISTIVITY OF STRAINED ROCKS (IN JAPANESE)
YAMAZAKI, YOSHIO.
ZISIN, V. 20, NO. 2, P. 138-139 1967
Subfile: G
Descriptors: *ELECTRICAL PROPERTIES; *JAPAN; *RESISTIVITY; *STRAINED ROCKS; *VOLCANIC ROCKS

18/5/12
429746 67-10260-G
OPREDELENIYE NEKOTORYKH ELEKTRICHESKIKH SVOYSTV EFFUZIVNYKH POROD ARMENII (DETERMINATION OF SOME ELECTRICAL PROPERTIES OF VOLCANIC ROCKS OF ARMENIA)
MOHAMMED, SAMI SOLIMAN.
MOSKOV. UNIV. VESTNIK, SER. 4, NO. 4, P. 102-105 1966
Subfile: G
Descriptors: *ARMENIAN S.S.R.; *ELECTRICAL PROPERTIES; *PHYSICAL PROPERTIES; *U.S.S.R.; *VOLCANIC ROCKS
?cost

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   $9.20  23 Types
   $0.91  Dialnet
  $23.42  Estimated cost this file
  $23.74  Estimated total session cost   0.164 Hrs.
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   $0.97  Dialnet
  $24.26  Estimated cost this file
  $24.58  Estimated total session cost   0.173 Hrs.

File  58:GEOARCHIVE - 74-85/Jul
(Copr. Geosystems)

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      S1    1131  ALTERATION
      S2     884  RESISTIVITY
      S3     803  CONDUCTIVITY
      S4    8978  VOLCANIC
      S5   45999  ROCK? ?
      S6    4708  VOLCANIC(W)ROCK? ?
      S7       0  ALTERATION AND (RESISTIVITY OR CONDUCTIVITY) AND
                  VOLCANIC()ROCK? ?
      S8    4737  ELECTRICAL
      S9   20584  PROPERT?
     S10     103  ELECTRICAL(W)PROPERT?
     S11   15214  IGNEOUS
     S12   45999  ROCK? ?
     S13    3381  IGNEOUS(W)ROCK? ?
     S14       1  ELECTRICAL()PROPERT? AND IGNEOUS()ROCK? ?
               1  S14
            1131  S1
               0  S7
     S15       0  (S14 AND S1) NOT S7
            1131  S1
             884  S2
             803  S3
            3381  S13
     S16       0  S1 AND (S2 OR S3) AND S13
               0  S16
               0  S15
               0  S7
     S17       0  S16 NOT (S15 OR S7)
            4708  S6
             103  S10
               0  S7
               0  S15
               0  S17
     S18       2  (S6 AND S10) NOT (S7 OR S15 OR S17)
?c 14 or 18
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              2  18
     S19      3  14 OR 18
?t 19/5/all


 19/5/1
0517992   GA438000981
   Electrical properties of the crust and the upper mantle under a belt of
Quaternary volcanoes of the Canadian cordillera, related to the sp reading
from north-east Pacific ridge
   VAN NGOC, P; BOYER, D
   C R Hebd Seances Acad Sci Ser D (Paris) 1978  JRNL CODE:  CRASDI
   287/4 P199-202
   LANGUAGE: FRENCH
   DESCRIPTORS: GEOELECTRICITY; CRUST; UPPER MANTLE; VOLCANIC ROCKS; SEA
FLOOR SPREADING
   AUXILIARY DESCRIPTORS: CORDILLERAN REGION; QUATERNARY
   DESCRIPTOR CODES: 687000; 708900; 708600; 546000; 717000
   AUXILIARY DESCRIPTOR CODES: 719000; 090000

 19/5/2
0429642   GA344000900
   Dependence of the electrical properties of igneous rocks in the Tashkent
seismic zone on moisture content, pressure and temperature
   BAKIYEV, MK; BONDARENKO, AT; BAKIYEV, MK
   Dokl Acad Sci USSR Earth Sci Sect (Washington DC) 1976 JRNL CODE: DASUEI
   222/1-6 P18-20
   LANGUAGE: ENGLISH
   DESCRIPTORS: EARTHQUAKE PREDICTION; GEOELECTRICITY; PHYSICAL PROPERTIES
OF ROCKS
   AUXILIARY DESCRIPTORS: UZBEKISTAN
   DESCRIPTOR CODES: 682400; 687000; 540300
   AUXILIARY DESCRIPTOR CODES: 431000

 19/5/3
0343761   GA261002804
   Relationship between electrical properties and structure of
eruptiverocks in the Stiavnica island, Stiavnicke Pohorie, Slovakia
   ONDRA, P; KOZEL, J
   Vestn Ustred Ustavu Geol (Prague) 1974  JRNL CODE:  VUUGE
   49/6 P321-329
   LANGUAGE: ENGLISH
   DESCRIPTORS: ROCK STRUCTURE; VOLCANIC ROCKS; ELECTRICAL PROSPECTING
   AUXILIARY DESCRIPTORS: SLOVENSKO
   DESCRIPTOR CODES: 540500; 546000; 334700
   AUXILIARY DESCRIPTOR CODES: 337000
?
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100 MW GEOTHERMAL RESOURCE CONFIRMATION

I. Objectives:

"Complete design of the geothermal demonstration program called for in Action Item 17.1 of the 1983 Power Plan, modifying that program to eliminate purchase of 10 megawatts of capacity but proceeding to confirm a geothermal site capable of supporting 100 megawatts, at a cost not to exceed $10 million over several years."

Bonneville's objectives to implement Action Item 9.3 are threefold:

A. Design a program to promote geothermal resource confirmation which, when implemented by Bonneville, would result in confirmation of at least one environmentally acceptable geothermal resource within the region, capable of supporting a 100 average megawatts of electrical energy for 30 years.

B. Provide assurance that the electrical power generated from the resource, after it is confirmed, will be made available to the region when it is needed, at competitive prices.

C. Complete design of the confirmation program by the end of FY 1988.

The confirmation program proposed under Action Item 9.3 will be projected to cost the ratepayers, from the time it is implemented, no more than $10 million and will be carried out over a period of not more than six years. Successful completion of the confirmation program plan is contingent upon: cooperation and participation of interested parties in the geothermal community; satisfactory resolution within Bonneville of overlapping policy issues regarding resource acquisition strategies; and sufficient funding to pay for the services of technical consultants to evaluate resource-specific issues germane to various confirmation strategies, if needed.

II. Tasks:

A. Background: The 1983 Power Plan proposed that Bonneville develop a geothermal demonstration program to encourage confirmation of the region's geothermal resources. Specifically, the Plan recommended that Bonneville develop and implement a geothermal demonstration program that guaranteed the purchase of electricity from the first 10 average megawatts generated at the most promising environmentally acceptable site available in the region. However, after objections were raised that the process envisioned (in Action Item 17.1) would be too costly for the region to subsidize, the Council stepped back from advocating a single, site-specific power plant demonstration project and focused instead on the preliminary problem of resource confirmation. The problem, therefore, is for Bonneville to identify which confirmation strategy the agency should choose to achieve the objective recommended by the Council.

The identification and evaluation of alternative confirmation strategies is already underway. Bonneville has undertaken the following actions:

1. Bonneville has solicited and received letters expressing ideas about, or interest in, the proposed 100 MW confirmation program from nine development companies, two regional State Energy Offices, and one regional utility. In addition, Bonneville staff have met with or had extensive telephone conversations with these people regarding geothermal resource confirmation in the Pacific Northwest.

2. For the purposes of planning and policy review, Bonneville has made an assessment of the nature and scope of the problem of confirming a 100 MW geothermal resource in the Pacific Northwest. This analysis was based on the advice and information provided by an experienced geothermal exploration and reservoir engineering consulting firm.

3. Bonneville presented its current assessment of the problem of developing a Bonneville-sponsored geothermal confirmation program at the section meeting of the Geothermal Resources Council (GRC) in Bend, Oregon, on September 24, 1986. The GRC is an industry association with an interest in resource development in the Pacific Northwest. A preview of this presentation was made on June 26, 1986, at the Annual EPRI Geothermal Conference held in Portland. Bonneville staff discussed the need for strategic planning to confirm regional geothermal resources and described a spectrum of confirmation strategy alternatives along with their associated policy implications.

4. Bonneville has developed a separate public involvement plan for this confirmation program. The purpose of this plan is to identify the appropriate means for including the various publics into the planning process. The plan identifies informal as well as systematic opportunities for members of the public to be informed about issues relevant to Bonneville's strategic planning effort, express their opinions, and make recommendations which the agency will consider before making decisions.

B. Scope of Work:

1. Organize a geothermal resource confirmation working group. Bonneville will need help in designing a resource confirmation program. The agency will solicit participation in a working group. Involvement will be voluntary and open to all interested parties. The working group will provide information and help Bonneville's project team evaluate the various confirmation strategies. The group's function will be to offer suggestions and critique on the work of the project team. Individual responses, as opposed to group consensus, will be encouraged.

2. Prepare an initial scoping paper. Bonneville will write an initial scoping paper that will describe the several alternative strategies that have been suggested to the agency as ways to support resource confirmation. The working group will be mailed copies of this scoping paper and be asked to comment. A summary of the comments received will then be distributed back to the group.

3. Develop an in-depth issue paper(s), as needed). Bonneville will develop an issue paper(s), that will focus on the unresolved issues associated with each alternative confirmation strategy. The issue paper(s) will analyze the problems of adopting any particular strategy as the recommended means to support resource confirmation. The working group will receive copies of the issue paper(s) and be asked to respond. They will also receive a follow up summary of all of the responses received by the agency.

4. Convene public meetings, depending on the level of interest. Depending on the level of interest generated by the scoping and issue paper(s), Bonneville will convene meetings to discuss various issues and to exchange information. Bonneville will also mail updates to all interested parties as progress is made during the planning process.

5. Prepare a draft confirmation program plan. After evaluating all of the comments received on the issues, Bonneville will prepare a report summarizing the analysis of the issues raised by the working group during the planning process. A recommended or preferred program strategy for support of geothermal resource confirmation will be included. This report will: clarify Bonneville's role and the roles of others in the confirmation process; identify the most likely participants; identify the risks, timing and costs of the confirmation alternatives; and establish the structure of a recommended confirmation program.

   Flexibility will be built into the plan to allow for budget changes as well as uncertainty in the administration of the program or other contingencies not anticipated. The confirmation program plan will identify the "triggers" or circumstances, under which the program will be considered for implementation.

6. Submit draft confirmation program plan for review. Review of the issues and alternative strategies analyzed during the planning process, including Bonneville's recommendations for a preferred program strategy, will be submitted to the working group and other interested publics for review.

7. Obtain final approval by Bonneville's management. After review by the working group and other publics, any comments received will be evaluated, and the plan will be modified as appropriate. It will then be circulated for final agency review and approval.

III. Key Decision Points:

Program Tasks/Milestones	Scheduled Start/Finish
Solicit participation in the resource confirmation working group	Mar 1987
Write and distribute an initial planning paper to the working group	Apr–May 1987
Develop an issue paper that describes the range of confirmation strategies and their associated issues	June–July 1987
Distribute the issue paper and solicit responses from the working group	Aug–Sept 1987
Evaluate responses to the issue paper and present the information at a public meeting, if needed	Oct–Nov 1987
Draft program document outline (chapters and sections); prepare guidelines/procedures for conducting program; write proposed plan	Dec–Feb 1988
Conduct public review of proposed program plan	Mar–Apr 1988
Revise program plan as appropriate	May–June 1988
Submit program recommendations to Bonneville's management for review and approval	July–Aug 1988
Issue final program plan	Sept 1988

IV. Level of Effort: The total program will run through the end of FY 1988, requiring one full-time Bonneville staff person and one three-quarter time staff support for public involvement (1.75 FTE) per year. Participation of the working group will be indispensable for the successful development of the program.