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**Field Geologic Log**  
**for**  
**Continental Scientific Drilling Program Corehole VC-2B**  
**Valles Caldera, New Mexico**

by

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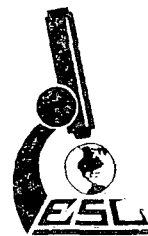
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## ABSTRACT

VC-2B, the third Continental Scientific Drilling Program (CSDP) corehole in the Valles caldera, was completed in October 1988 at a depth of 5780 ft (1761.7 m) and a bottom-hole temperature of nearly 300°C. Drilled in the Sulphur Springs area, in the west-central portion of the caldera, VC-2B penetrated most of the thick, Valles intracaldera ignimbrite sequence as well as precaldera basement rocks ranging in age from Miocene to Precambrian. Major units intersected are as follows: 0-113.5 ft (0-34.6 m) -- landslide debris; 113.5-551.6 ft (34.6-168.2 m) -- interstratified debris-flow deposits and epiclastic sedimentary rocks (<1.12 Ma); 551.6-1196.8 ft (168.2-364.8 m) -- Tshirege Member of the Bandelier Tuff (1.12 Ma); 1196.8 -1221 ft (364.8-372.1 m) -- S<sub>3</sub> clastic deposits (1.45-1.12 Ma); 1221-1965.2 ft (372.1-599 m) -- Otowi Member of the Bandelier Tuff (1.45 Ma); 1965.2-2434 ft (599-741.8 m) -- Lower Tuffs (2.8 Ma, possibly as old as 3.6 Ma); 2434-2619 ft (741.8-798.2 m) -- Santa Fe Group sandstone (Miocene); 2619-3435.5 ft (798.2-1046.9 m) -- Permian Yeso Formation; 3435.5-4252 ft (1046.9-1295.9 m) -- Permian Abo Formation; 4252-4962.8 ft (1295.9-1512.6 m) -- Pennsylvanian Madera Limestone; 4962.8-5113 ft (1512.6-1558.4 m) -- Pennsylvanian Sandia Formation; 5113-5780 ft (1558.4-1761.7 m) -- Precambrian quartz monzonite.

Whereas much of the intracaldera volcanic sequence and the deep Precambrian quartz monzonite have been extensively fractured and brecciated (both tectonically and hydrothermally), intervening Paleozoic strata have undergone little structural disruption. This disparity is mirrored by the distribution and intensity of hydrothermal alteration and vein mineralization.

Rocks in the upper 800 m and lower 250 m of VC-2B are extensively altered, brecciated and veined. The Paleozoic rocks between these zones are essentially unaltered and only sparsely veined. Alteration in near-surface landslide debris is in part pre-slide in age. Below the slide, sericitic alteration -- illitic, mixed-layer illite/smectite changing with depth to illite -- prevails to a depth of about 300 m; this alteration is overprinted by kaolinization to a depth of 161.8 m. Chlorite-sericite (illite) alteration prevails between 300 and 800 m. Deep alteration is primarily propylitic, but the upper 12.5 m of the Precambrian quartz monzonite is intensely chlorite-sericitized. Near the contact with the quartz monzonite, siliciclastic rocks of the Pennsylvanian Sandia Formation have the appearance of calc-silicate hornfels, complete with large, tabular, translucent gray, sieve-textured porphyroblasts rimmed with chlorite. Preliminary petrographic examination of these rocks, however, has so far revealed no secondary phases indicative of high-temperature

thermal metamorphism; the gray porphyroblasts are anhydrite, possibly of diagenetic origin.

Hydrothermal veins and breccias are widespread in the VC-2B core, particularly in the more highly altered zones above and below the Paleozoic sequence. Identified vein minerals comprise quartz, calcite, ankerite, dolomite, fluorite, anhydrite, barite, epidote, wairakite, sericite, chlorite, hematite, and pyrite as well as rare rhodochrosite, chalcopyrite, chalcocite, sphalerite, galena, tetradymite (?), stibnite (?), and pyrargyrite. The latter two metallic minerals and rhodochrosite occur only at high elevations in the corehole; the other sulfides (and telluride?), except pyrite, are apparently confined to Paleozoic and Precambrian hosts.

The age(s) of secondary minerals in rocks below the intracaldera volcanic sequence remain(s) to be determined, but initial evidence suggests that they may be related in part to the currently or recently active Valles hydrothermal system. Homogenization temperatures for primary fluid inclusions trapped in several of these deep veins closely match current temperatures. Furthermore, several of the deeper veins apparently contributed significant amounts of chloride to the otherwise essentially chloride-free drilling mud when first encountered; if not deposited by the contemporary hydrothermal system, these veins may at least be channeling its thermal fluids. If this is so, VC-2B may have penetrated "stacked" hydrothermal cells separated by essentially impermeable Paleozoic strata.

## INTRODUCTION

On October 22, 1988, Continental Scientific Drilling Program corehole VC-2B, in the Sulphur Springs area of the Valles caldera (Fig. 1), was completed at a depth of 5780 ft (1761.7 m) and a bottom-hole temperature exceeding 290°C. A collaboration involving Los Alamos National Laboratory (LANL), Sandia National Laboratories' Geoscience Research Drilling Office (GRDO), Tonto Drilling Services, and the University of Utah Research Institute (UURI), VC-2B was drilled not only to investigate, measure, and sample the high-temperature, liquid-dominated Sulphur Springs hydrothermal system (Goff et al., 1985) but in doing so to address a broad range of related scientific objectives (Hulen et al., 1988). Successful completion of the hole helps ensure that these objectives will be achieved.

Through the efforts of Tonto Drilling Services, core recovery for VC-2B was nearly 100%. The core provides the first continuous and undisturbed (as opposed to cuttings) record of the complex Valles intracaldera ignimbrite sequence and the subjacent Paleozoic to Precambrian basement. It also preserves delicate fractures, breccias, hydrothermal alteration textures, and paragenetic relationships, extremely useful (and hitherto unavailable) for reconstructing the Valles caldera's tectonic and hydrothermal history.

This report presents a detailed preliminary log of the lithology, stratigraphy, structure, hydrothermal alteration,

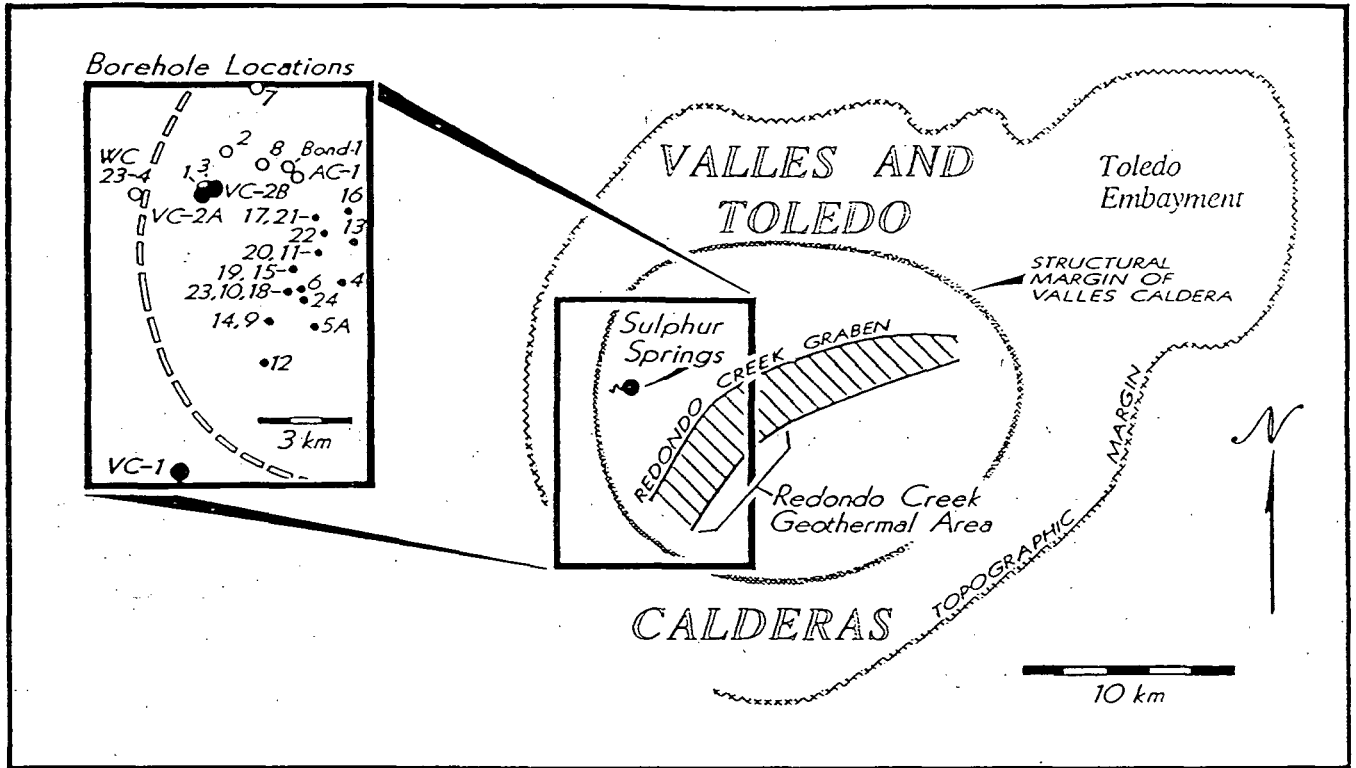


Figure 1. Location map showing positions of scientific coreholes (larger closed circles, inset at left) and geothermal wells (open circles and small, closed circles) completed to date in the Valles caldera complex.

veining, and metallic mineralization encountered in VC-2B. The log is designed to help guide the diverse research efforts of the 94 geoscientists forming the VC-2B research team (Appendix 2). Abbreviations used in the log are listed in Appendix 1.

### STRATIGRAPHY AND LITHOLOGY

The intracaldera ignimbrite sequence and underlying Paleozoic to Precambrian basement penetrated by VC-2B (Fig. 2) can be correlated readily with rocks exposed within and near the Valles caldera or penetrated by previous geothermal or scientific drill holes (Fig. 1). We are reasonably confident of these correlations, but stress that their confirmation must await detailed study by the research team. Major units intersected in VC-2B are interpreted by us as follows:

Surface to 113.5 ft (34.6 m): Landslide Debris--

Coarse, unsorted, generally matrix-supported breccia, with clasts up to at least 4.5 ft (1.4 m) in diameter; highly variable clast to matrix ratio; clasts represent most pre- and intracaldera lithologies; many of the clasts are red, hematitic, and appear to have been derived from the Permian Abo Formation.

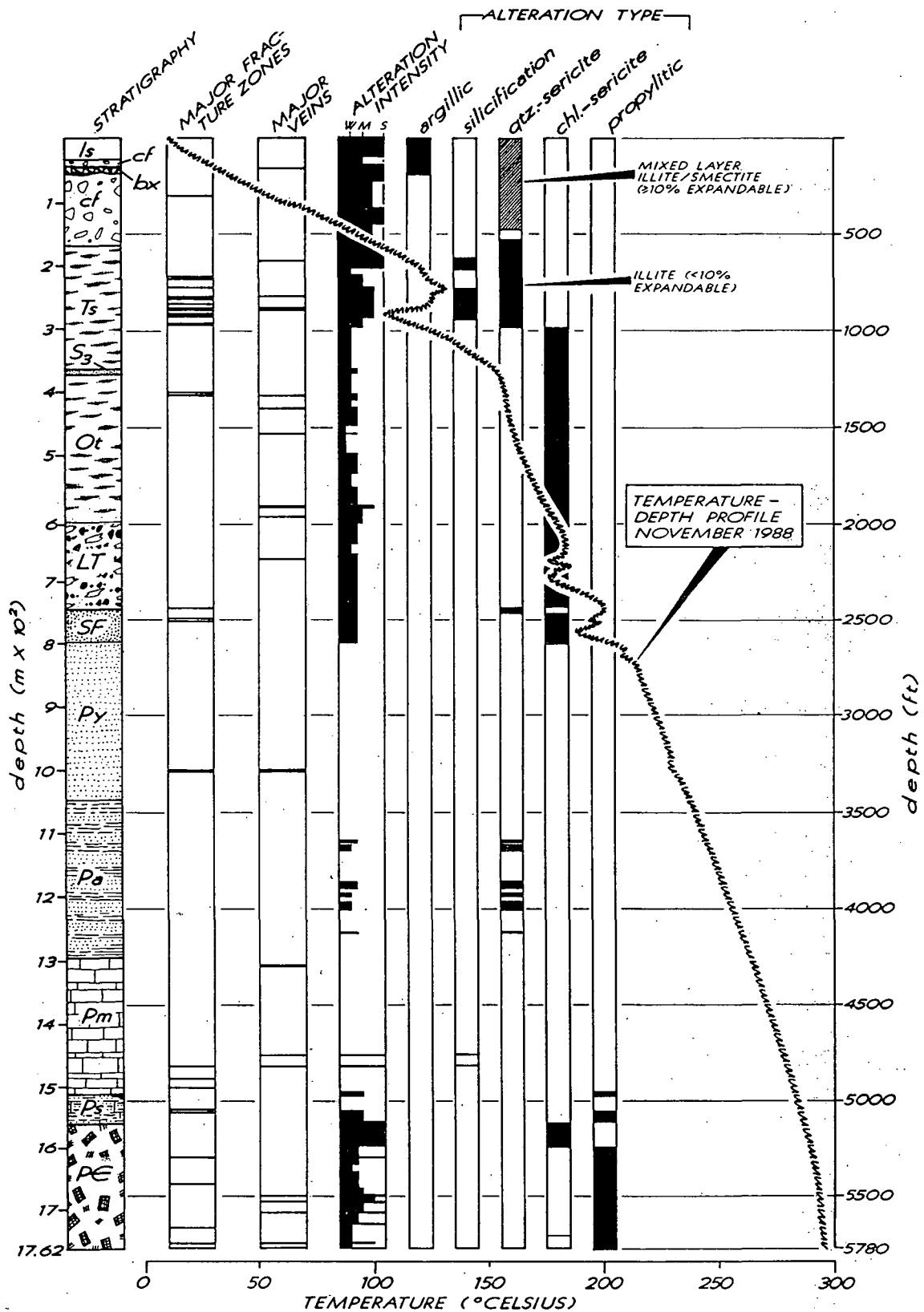


Figure 2. Summarized geologic log for CSDP corehole VC-2B, Sulphur Springs area, Valles caldera, New Mexico. ls--limestone; cf--caldera-fill clastic rocks; bx--hydrothermal breccia and dacite porphyry; Ts--Tshirege Member of Bandelier Tuff; S<sub>3</sub>--S<sub>3</sub> clastic deposits; Ot--Otowi Member of Bandelier Tuff; LT--Lower Tuffs; SF--Santa Fe Group sandstone; Py--Permian Yeso Fm; Pa--Permian Abo Fm; Pm--Penn. Madera Limestone; Ps--Penn. Sandia Fm; PC--Precambrian quartz monzonite.

1135-551.6 ft (34.6-168.2 m): Interstratified Debris-Flow Deposits and Epiclastic Sedimentary Rocks (< 1.12 Ma) -- Debris-flow deposits resemble overlying landslide breccia, but are generally more monolithologic, consisting largely of sandstone clasts in a clay-rich, sandy matrix; epiclastic siltstones and sandstones are bleached, clay-rich, and commonly contorted to intraformationally brecciated; interbedded accretionary lapilli tuff and tuffaceous sandstone to conglomerate between 467.6 ft (142.5 m) and 487 ft (148.4 m); debris-flow breccia consisting entirely of red, remobilized Abo Formation shale and sandstone between 496 ft (151.2 m) and 530 ft (161.5 m); unusual dacite or andesite porphyry, with associated hydrothermal breccia, apparently intrudes this sequence between 152.2 ft (46.4 m) and 183 ft (55.8 m).

551.6-1196.8 ft (168.2-364.8 m): Tshirege Member of the Bandelier Tuff (1.12 Ma) -- Non- to densely welded, crystal-rich rhyolite ash-flow tuff; extremely lithic-rich intervals, 551.6-571.7 ft (168.2-174.3 m), 1030-1035.3 ft (313.9-315.5 m), 1052.7-1089.5 ft (320.8-332.1 m), and 1103.2-1134.2 ft (336.2-345.7 m); the latter two lithic breccias are strongly fines-depleted, and consist

principally of clasts derived from the Permian Abo Formation and the Pennsylvanian Madera Limestone; well-developed vapor-phase cavities from 663 ft (202.1 m) to 674 ft (205.4 m).

1196.8-1221 ft (364.8-372.1 m): S<sub>3</sub> Clastic Deposits (1.45-1.12 Ma) -- Interbedded dacite breccia, tuffaceous sandstone breccia, and sandstone; important marker horizon separating the Tshirege and Otowi Members of the Bandelier Tuff.

1221-1965.2 ft (372.1-599 m): Otowi Member of the Bandelier Tuff (1.45 Ma) -- Dominantly densely welded, crystal-rich, rhyolite ash-flow tuff; much of the unit is very hard, flinty in appearance; locally contains dark, relict glass; lithic-rich zone, 1461.8-1488 ft (445.5-453.5 m); mafic-appearing pumice, 1869-1888 ft (569.6-575.4 m); possible fused fallout tuff (50%+ pumice, (Guaje pumice bed?)), 1958-1965.2 ft (596.8-599 m).

1965.2-2434 ft (599-741.8 m): Lower Tuffs (2.8 Ma?)-- Non- to densely welded, crystal-rich and (especially) lithic-rich ash-flow tuff; commonly 20%, and locally up to 70% lithic fragments, dominantly porphyritic andesite; distinctive, micro-eutaxitic texture, 2003.3-2030.5 ft (610.6-



618.9 m), with fiamme averaging only 3-4 mm in length; extremely lithic-rich zone (lag breccia), 2209.5-2223.2 ft (673.4-677.6 m); fines-depletion (degassing) pipes prominent, 2236-2266.7 ft (681.5-690.0 m).

2434-2619 ft (741.8-798.2 m): Sandstone of the Santa Fe Group (Miocene) --Friable, porous, bleached and punky-appearing; massive to steeply cross(?) bedded, very possibly of aeolian origin in part; highly contorted and intruded by hematitic clastic dikes, 2434-2452 ft (741.8-747.3 m); complex interval of interbedded debris-flow deposits, tuffs, carbonates (?), and sandstones, 2452-2469.5 ft (747.3-752.7 m) (possibly Miocene Cochiti Formation equivalent).

2619-3435.5 ft (798.2-1047.1 m): Permian Yeso Formation -- Dominantly hematitic, fine-grained, plane- to wavy-bedded, commonly bioturbated, locally argillaceous sandstone; anhydrite nodules and filled burrows common; thin anhydrite, limestone, and mudstone beds locally present; volcanoclastic conglomerate, 3305.5-3334 ft (1007.5-1016.2 m), with large porphyritic andesite cobbles; arkosic conglomerate with granitic

pebbles and cobbles below this sub-unit to a depth of 3358 ft (1023.5 m)

3435.5-4252 ft (1047.1-1295.9 m): Permian Abo Formation -- Interbedded hematitic arkosic mudstones and sandstones; thin limestone and dolomite interbeds as well as diagenetic calcite nodules locally present.

4252-4962.8 ft (1295.9-1512.6 m): Pennsylvanian Madera Limestone -- Interbedded, relatively pure to argillaceous limestones and siliciclastic rocks; locally very fossiliferous (brachiopods, fusulinids, corals, pelecypods); black, pyritic and possibly organic-rich shales and mudstones locally present; massive chert, 4879.5-4896.5 ft (1487.2-1492.3 m); very sulfide-rich (pyrite and sphalerite) "black" mudstone, 4941-4944.2 ft (1505.9-1506.9 m).

4962.8-5113 ft (1512.6-1558.4 m): Pennsylvanian Sandia Formation -- Dominantly interbedded mudstone, siltstone, sandstone and argillaceous to sandy limestone; much of the unit seems recrystallized.

5113-5780 ft (1558.4-1761.7 m) (total depth):

Precambrian Porphyritic Biotite (+ Hornblende)

Quartz Monzonite -- Very distinctive, coarsely porphyritic, with 20-25% large potassium feldspar phenocrysts (up to 3 X 2 cm in X-section) embedded in a medium-crystalline, granitic matrix; average about 10-12% disseminated mafic minerals; original magnetite (ilmenite ?) and sphene now commonly converted to leucoxene; aplite, fine-grained granite, and granodiorite dikes locally present.

STRUCTURE

The entire stratigraphic sequence outlined above has undergone at least some structural disruption, but the effects of that disruption are highly variable; fracturing and brecciation are strongly dependent on rock type and elevation in the Valles hydrothermal system. The Bandelier Tuff, associated ignimbrites and volcanoclastic sedimentary rocks are commonly intensely fractured (Fig. 2), both tectonically and hydrothermally; the deep Precambrian basement is similarly but moderately fractured. Curiously, however, the intervening Paleozoic sedimentary sequence is overall only weakly fractured, and the Permian redbeds (Abo and Yeso Formations) remain (except for fissile shales and mudstones) essentially undisturbed.

As in corehole VC-2A, compaction foliation dips in the Tshirege and Otowi Members of the Bandelier Tuff are

essentially identical, indicating that unlike the Valles caldera, the Toledo caldera (formed simultaneously with eruption of the Otowi at 1.45 Ma) did not undergo structural resurgence; had it done so, dips presumably would be steeper in the Otowi than in the Tshirege. Curiously, compaction foliation dips throughout the Bandelier Tuff are much shallower in VC-2B (generally 10- 20°) than in VC-2A (up to 50°). The relatively steep dips of VC-2A are apparently due to rotation along faults rather than resurgent doming of the Valles caldera.

The most intense fracturing encountered in VC-2B is hosted by densely welded ignimbrites of the Tshirege Member of the Bandelier Tuff in the interval 775-990 ft (236.2-301.7 m). Several major fault zones (tectonic breccias) in this interval are accompanied by widespread stockwork fracturing of the affected tuffs. These faults and breccias are strongly altered, and have clearly focused high-level fluid flow in the Valles hydrothermal system.

Between 1320.5 ft (402.5m) and 1579.5 ft (481.4m), the Otowi Member of the Bandelier Tuff is extensively but moderately broken by hydraulic fracture networks and local hydrothermal breccias. Most of these are partially infilled with bladed, "fishscale" calcite, a morphology which can indicate deposition from boiling hydrothermal solutions; it is possible that the fluids responsible here for hydraulic rock rupture deposited this calcite in the resulting open spaces.

The Lower Tuffs and underlying Santa Fe Group sandstones are largely unfractured although moderately altered (Fig. 2). Permeability in these units is probably of primary origin.

Considering the location of VC-2B near the ring-fracture margin of a major caldera, the Permian Abo and (particularly) Yeso Formations are remarkably unfractured. Intervals of several hundred feet in the Yeso, in fact, are nearly devoid of fractures, and several intact cores exceeding 10 ft (3.1 m) in length were obtained from this unit. The underlying Abo is locally broken and rubblized, but primarily in fissile shales and mudstones; we suspect that these are not throughgoing tectonic features. Only one structure in the entire 1633 ft (497.7 m)-thick Permian redbed sequence has apparently guided extensive thermal fluid flow--an altered and mineralized fault centered at a depth of 3293 ft (1003.7 m) (Fig. 2).

The Pennsylvanian Madera Limestone and Sandia Formations are more fractured than the overlying Permian sequence, perhaps because of their more brittle primary textures. As a result, these units host a few more, but still widespread, hydrothermal veins.

The contact between the Sandia Formation and underlying Precambrian quartz monzonite coincides with a subhorizontal, intensely sheared "melange" of various lithologies--actually what could be described as a protomylonite--spanning the interval 5108.2-5119 ft (1556.9-1560.2 m).

This unique structure suggests the possibility that here the Paleozoic sequence may have been thrust over the Precambrian (perhaps during Laramide compression).

Although not as disrupted as the high-level ignimbrite sequence, the deep Precambrian quartz monzonite penetrated by VC-2B also hosts numerous fractures and breccias of both tectonic and hydrothermal origin. In addition, the upper 41 ft. (12.5 m) of the unit is intensely altered, indicating past invasion by thermal fluids along now-healed fractures (perhaps in part developed during weathering and unloading).

#### ALTERATION AND MINERALIZATION

Alteration: Hydrothermal alteration and mineralization in VC-2B reflect the distribution both of secondary permeability along the fractures and breccias just described and of primary permeability in certain clastic rocks as well as non- to weakly-welded ignimbrites. Accordingly, the high-level intracaldera ignimbrite sequence and deep Precambrian basement are separated by essentially unaltered Paleozoic strata (Fig. 2). Since current temperatures in these Paleozoic rocks are more than sufficient for relatively high-grade hydrothermal alteration, the lack of that alteration most likely reflects insufficient host rock permeability. This suggests the possibility (assuming that all or most alteration encountered is related to the current or recently active Valles hydrothermal system) that the Paleozoic rocks, particularly the Permian redbeds, form a

largely impermeable barrier separating "stacked" hydrothermal cells. Hydrothermal alteration in VC-2B is most pervasive and intense from the surface to a depth of 990 ft (301.7 m). Much (though not all) of the alteration in landslide debris above 113.5 ft (34.6 m) probably predates development of the slide; in an otherwise punky, clay-rich matrix, absolutely fresh Madera limestone clasts are locally present. Between 113.5 ft (34.6 m) and 183 ft (55.8 m), epiclastic sediments, debris-flow breccias, and the dacite/andesite porphyry-hydrothermal breccia interval are strongly altered to mixed-layer illite/smectite and phengite/smectite, quartz, calcite, and kaolin; the latter mineral is particularly abundant in association with the porphyry/breccia interval. The same alteration without kaolin affects most of the debris-flow/epiclastic interval to a depth of 551.6 ft (161.8 m). Between that depth and 775 ft (236.2 m), illite is the principal secondary phase; the illite is accompanied by locally intense silicification below 735 ft (224 m). Densely welded ash-flow tuffs in the interval 775-990 ft (236.2-301.7 m) are intensely quartz-sericitized (here sericite = illite), silicified, and hydrothermally etched along fractures and between breccia clasts. This dissolution has resulted in secondary porosities locally reaching at least 10 vol.%. Note that this etched zone corresponds to a prominent reversal in the most recently obtained temperature profile (Fig. 2).

Chlorite-sericite alteration is the dominant alteration type between 990 ft (301.7 m) and 2619 ft (798.2 m). It is particularly well-developed in the Lower Tuffs and Santa Fe Group sandstones.

Paleozoic strata intersected in VC-2B are mostly unaltered, though a few coarser-grained sandstones in the Abo Formation appear to have been weakly to moderately sericitized. Clay fractions extracted from selected samples of these rocks are shown by XRD to contain abundant mixed-layer illite/smectite with up to 45% expandable interlayers, far more than would be expected at presently prevailing temperatures (e.g Hedenquist and Reid, 1985). Most of these clays are believed to represent the rocks' older, relatively low-temperature diagenetic signatures. We suspect that they have retained these signatures because of their host rocks' impermeability; even though heated to high temperatures, the clays were isolated from potassium-bearing hydrothermal fluids, and there was insufficient local potassium to effect the transformation to low-expandability illite. Alternatively, the clays were heated to these high temperatures very recently, and are even now transforming to illites at depth.

With the exception of intense chlorite-sericitization of the upper Precambrian (Fig. 2), propylitic alteration (chlorite-sericite-epidote-calcite-hematite) apparently prevails at depth in VC-2B. Intensity of this



propylitization is highly variable, but strongest in association with hydrothermal breccias and veins.

Much of the Sandia Formation below a depth of 4962 ft (1512.3 m), although tentatively included in the deep propylitic alteration zone, appears to be recrystallized and looks very much like a mottled, fine-crystalline calc-silicate rock. However, preliminary petrographic examination, XRD analysis, and electron-beam microanalysis have identified only epidote, illite, mixed-layer illite/smectite, chlorite, calcite, hematite, wairakite, and anhydrite, with no minerals characteristic of higher-temperature thermal metamorphism. The anhydrite oddly occurs as large, euhedral, sieve-textured "porphyroblasts" with chloritic rims; these may be of diagenetic origin, but, along with this entire unusual zone, deserve much more detailed investigation.

Mineralization: Mineralized veins and breccias are abundant in the VC-2B core. Mirroring the intensity of fracturing and hydrothermal alteration, they occur primarily in the intracaldera volcanic sequence and the deep Precambrian basement. Vein textures and mineral assemblages are diverse, and rather than being described exhaustively here, are catalogued in Table 1.

Based on our preliminary work, it appears that typical "epithermal" metallic vein minerals (pyrargyrite, stibnite) in VC-2B are confined to the intracaldera volcanic/sedimentary sequence. Chalcocite, chalcopyrite,

Table 1. VC-2B: Major hydrothermal vein and open-space-filling zones

DEPTH	IDENTIFIED HYDROTHERMAL VEIN AND OPEN-SPACE-FILLING MINERALS
162.5 - 166.2'	QTZ, CHALCEDONY, ANK, CAL, PY, KAOL
169.5 - 183'	QTZ, CHALCEDONY, ANK, CAL, PY, KAOL, <u>STIBNITE?</u>
431 - 431.8'	QTZ, CAL
819.9 - 824'	QTZ, SER, PY
881 - 897'	QTZ, SER, PY
1342.5 - 1346'	SER, CHL, CAL, PY
1350 - 1352.5'	SER, CHL, CAL, PY
1405.5 - 1405.7'	SER, CHL, CAL, PY(tr)
1414.5 - 1417'	SER, CHL, CAL, PY(tr)
1525 - 1528'	SER, CHL, CAL
1912.5 - 1932'	SER, CHL, CAL, PY
1957 - 1958'	SER, CHL, CAL, PY
3291 - 3293.5'	QTZ, SER, CHL, CAL, <u>BARITE</u> , ANH, <u>SPHALERITE</u> , <u>CHALCOCITE</u>
4293 - 4296.5'	QTZ, SER, CAL, CHL, PY
4325 - 4328'	CAL, PY
4565 - 4565.8'	QTZ, CAL
4687 - 4691'	CAL
4755 - 4763'	QTZ, SER, ANH, PY, <u>TETRADYMITE(?)</u>
4821.5 - 4829.5'	QTZ, CAL, EP, <u>WAIKAKITE</u> , <u>CHALCOPYRITE</u> , <u>BORNITE(?)</u>
4885.7 - 4887.7'	QTZ, CAL
4984.5 - 4997'	SER, EP, CAL, ANH, PY
5042.2 - 5043'	QTZ, SER, CAL
5061.8 - 5063'	SER, CAL, PY

TABLE 1 (continued)

5091 - 5093'	EP, CHL, CAL, PY
5303.5 - 5304'	QTZ, SER, CAL, PY
5401 - 5401.7'	QTZ, EP, CHL, CAL, PY
5403 - 5405'	QTZ, EP, CHL, CAL, PY
5447 - 5447.5'	QTZ, EP, CHL, CAL
5480.5 - 5482.7'	QTZ, EP, CHL, CAL, HEM
5485 - 5488.2'	QTZ, EP, CHL, CAL
5530 - 5335'	QTZ, EP, CHL, CAL, PY, <u>SPHALERITE</u>
5590.5 - 5594.3'	QTZ, SER, EP, CHL, CAL, PY
5655 - 5655.7'	QTZ, SER, EP, CHL, CAL, PY
5660.5 - 5662'	QTZ, SER, EP, CHL, CAL, PY
5730 - 5731.5'	QTZ, SER, EP, CHL, CAL, PY, <u>CHALCOPYRITE</u>
5750 - 5751.2'	QTZ, SER, EP, CHL, CAL, PY, <u>CHALCOPYRITE</u>
5756 - 5758.5'	QTZ, SER, EP, CHL, CAL, PY <u>CHALCOPYRITE</u>

Other zones with unusual mineralogy

927 - 934'	QTZ, SER, PY, <u>RHODOCHROSITE</u>
1152'	QTZ, SER, CHL, CAL, PY, <u>PYRARGYRITE</u>
1234 - 1240'	QTZ, SER, CHL, PY, <u>FLUORITE</u>
1257 - 1293.5'	QTZ, SER, CHL, PY, <u>FLUORITE</u>
1308 - 1314'	QTZ, SER, CHL, PY, <u>FLUORITE</u>
2183 - 2185'	CAL, <u>FLUORITE</u>

bornite (?) and other base-metal sulfides occur in veins only in Paleozoic and Precambrian rocks.

Further research is needed to determine whether or not these deep veins and associated alteration are related to the presently or recently active Valles hydrothermal system; preliminary fluid-inclusion evidence, however, suggests that they may be.

Homogenization temperatures for primary fluid inclusions in a variety of minerals from several of the deep veins are very close to presently measured temperatures (many of these samples contain coexisting primary vapor- and liquid-rich inclusions, indicating deposition from boiling hydrothermal fluids, so pressure corrections are unwarranted). While this does not conclusively prove vein mineralization from present or recent fluids, it is certainly suggestive evidence. Furthermore, many of these deep veins apparently yielded chloride-rich water to the drilling mud when first penetrated. If the veins were not deposited from presently circulating fluids, they may at least serve as contemporary fluid channels.

*FIELD GEOLOGIC LOG FOR COREHOLE VC-2B*

*(Abbreviations listed in Table 1)*

*Depth Scale 1in.=12ft.*

NOTE: MUCH OF THIS ALTERATION (TO 1135') PROBABLY PRE-DATES BRECCIA FORMATION

DEPTH	GRAPHIC LOGS										GRAPHIC GEOLOGY	NOTES, COMMENTS	DESCRIPTIONS
	PHENISTE	ALTERATION			STRUCTURING	VENING & VUG-FILL	YEMPLET PHASES						
	1 SER. (ILLITE)	2 SILIC. FLOTTA	3 SER. (SERP.)	4 CAL. CITE	5 DISS. PYRITE		1.1 VAR. M. PYRITE	2.1 GILORITE	3.1 CANTITE	4.1 PYRITE			
0													0-10' (RECOVERED 0.8'): EXTREMELY CLAY-RICH V. LT. GRAY TO LIGHT ORANGE-BROWNISH-GRAY MINOR DISS. SOEHLITE WHICH ALSO OCCURS AS AN IRREGULARLY-DISTRIBUTED STAIN.
10													
15-18.8												ALTY. CONTACT, 20' DIP	15-18.8: RECOVERED 0.1 (fr. 15-18): Clay-rich, sandy breccia; 2 to subrounded clasts up to at least 6 cm in dia.; extreme heterogeneity of clasts, which include obsidian and stony rhyolite (Redondo Creek Rhyolite 2) and intermediate-composition volcanics; also much variation in degree of alteration from totally altered to fresh - suspect much of the alteration pre-dates landslide
18.8-20.45													* AT 18.8' CONTACT BETWEEN THE VARIABLY-ALTERED BRECCIA ABOVE & STRONGLY ALTERED BRECCIA BELOW.
20.45-22												-60° DIP	18.8-20.45' Extremely clay-rich sandy, heterolithic breccia, much more pervasively altered than above, sticky/gooey when wet; clasts up to at least 6 cm in dia.; 2 to subrounded, including calcareous sandstone, porphyritic rhyolite, porphyritic andesite and basalt - many sandstone clasts bleached but still reddish, probably Permian Abo Formation; alteration of this deposit is intense, but in part, pre-dates breccia development because alteration mineralogy & texture sometimes truncated at clast margins.
22-42.1												-40° DIP	20.45-22': Fine-gr. sandstone (c. n 91.2, a few scattered vugs up to 1/8" & mm., filled with calcite, rimmed with unknown dark material; unit appears sheared/fractured locally (c. n 60) to core axis.
42.1-47.1												ALSO 15'	42.1-47.1': Clay-rich sandy breccia, as above; diss. pyrite concentrated in sericitized clasts.
47.1-49.7												MAPERIA LS. CLAST	47.1-46.6': Limestone clast, fresh wavy-bedded 46.6-47.6': sandy breccia as above 47.6-49.7': Limestone clast, as above
49.7-57.1												49.7'	49.7-57.1': sandy breccia, as above; appears to be a 2% disseminated shaly clast, dk. gray, which are selectively pyritized.
57.1-67.8												57.1'	57.1-67.8': same as above, except matrix becomes reddish-brown; suspect that this is a lobe of the landslide derived from the Abo Formation.
67.8-71.5												RED HEMATITIC ABO-DERIVED?	
71.5-77.5												67.8'	67.8-71.5': sandy br, as above, but not red, hematitic; also, this sub-unit is more clast-poor & even less pyritic - intervals up to 1 FT thick with almost no clasts larger than a few mm. dia.
77.5-85.4												SLIP PLANE DIP N 45°	* 71.5' irreg. slip plane w/ vague slick, w 45° dip, phenistite, illite on surface.
85.4-86.0													85.4-86.0': Rubble zone - probable fault
86.0-113.5													86.0-113.5': Clay-rich sandy breccia, as above disseminated pyrite extremely fine-kin. - really appears to post-date the matrix.
113.5-100													

DRILL HOLE VC-23 (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,

LOGGED BY J. HULEN & J. GARDNER  
 07/23/88

GRAPHIC LOGS										NOTES, COMMENTS	DESCRIPTIONS					
DEPTH	ALTERATION					VEINLET FILLINGS	GRAPHIC GEOLOGY	DIP	PHENIGITE			VEINLET PHASES				
	SERICITE	SILICIFICATION	CHL	CALCITE	DISS. PYRITE					QUARTZ	SERICITE		CHLORITE	CALCITE	PYRITE	
100																* 99.6-102 FT. selective pyritization of clasts
110																* 107.4-108': sticky, wet, rubble zone, prob. fault
118.5'																
115.2'																115.5-115.2': Fine- to coarse-grained pebbly volcanic sandstone, 10-20° dip
119.1'																115.2-119.1': sandy, clay-rich breccia, similar to the overlying debris flow - scattered black shale clasts, selectively pyritized.
121.5'																119.1-121.5': interbedded & well-bedded volcanoclastic siltstone and mudstone.
121.5'																121.5-129.1': distinctly bedded, interbedded volcanoclastic sandstone (dominant), siltstone & claystone; friable, extremely immature; feldspars & glass altered to clay (w/sericite?);
130																
139.1'																129.1-139.1': SANDY, CLAY-RICH BRECCIA, WHITE TO LT. GRAY, PROBABLY A DEBRIS-FLOW DEPOSIT; VERY SIMILAR TO LAND-SLIDE DEPOSIT HIGHER IN THE SECTION (ABOVE 115.5'); UNIT CONTAINS ANGULAR TO SUBROUNDED CLASTS OF PORPHYRY-IC FELSIC VOLCANIC ROCK, INTM-COMP. VOLC. ROCK, SANDSTONE, SHALE, FELSIC ASH-FLOW TUFF. CLASTS ARE ABOUT 3 CM. AVG. DIA. BUT UP TO 20 CM. - 50 CLASTS ARE LARGEST; MANY CLASTS HAVE BEEN ALTERED TO PHENIGITE PRIOR TO INCORPORATION IN BRECCIA. - HOWEVER THE PHENIGITE IS IN TURN POST-DATED BY SERICITE
140																* Qtz, PYRITE & CALCITE; MANY PHENIGITIC CLASTS ARE RIMMED W/PYRITE-RICH BANDS; WHOLE ROCK HAS A WEAK CALCITE "SOAK".
150																
152.2'																152.2-162.5': INTRUSION BRECCIA: ANGULAR TO SUBROUNDED CLASTS OF VOLC. SS & BRECCIA, AS ABOVE, IN A FELSIC(?) PORPHYRY MATRIX; MOSTLY PLAG. PHENOS. IN THE PORPHYRY - THESE ARE VARIABLY BUT COMMONLY INTENSELY ALTERED TO KAOLIN(?) SERICITE & MAYBE WEAK CALCITE; ENTIRE ROCK MOD-INTENSE CLAY-SER ALTERATION W/LOCAL SILICIFICATION; DISS. PY. INCREASES; SILICIFICATION CONCENTRATED AROUND RIMS OF CLASTS; SCATTERED, THIN, HYDROTHERMAL BRECCIA VEINS
160																162.5-166.2': HYDROTHERMAL BRECCIA, CLASTS UP TO 7CM. IN DIAMETER (AVG. 2 CM), MOSTLY THE PORPHYRY DESCRIBED ABOVE EMBEDDED IN A MEDIUM-BROWN SILICA-CARBONATE MATRIX - THIS ALSO CONTAINS MICROBRECCIA, ROCK FLOUR & QUARTZ BIPYRAMIDS.
162.5'																166.2-169.5': FELSIC(?) PORPHYRY AS ABOVE
166.2'																169.5-183.0': HYDROTHERMAL BRECCIA, AS ABOVE EXCEPT RICHER IN CLASTS (50-75%); TWO MATRICES, ONE BROWN SILICA-CARBONATE AS ABOVE; THE OTHER A CALCITE-Qtz-PYRITE ALTERED ROCK FLOUR; MUCH OF THE Qtz IS CHALCEDONIC, LINKS & FILLS OPEN SPACES. THIS UNIT IS QUITE VUGGY - THE VUGS ARE TYPICALLY ANGULAR & UP TO 2 CM IN DIAMETER.
170																
180																
183'																183-184.6': BRECCIA (debris flow?); soft, crumbly sandy, similar to 129.1-132.2', but intensely altered, possibly disrupted by faulting.
184.6'																
184.6'																184.6-198.6': SANDSTONE, massive fine- to med.-gr. med. to nearly sorted, lt.-med. gray, vague local bedding with 30-60° dip; vague mottling (auto-brecciation?) locally apparent - poss. local soft-sediment deformation!
190																
189.8'																* 189.8-191.3': numerous, clasts of sericitized tuff, & up to 6 cm. diameter.
198.6'																

DRILL HOLE VC-28 (FIELD LOG)

LOCATION SULPHUR SPRINGS, VALLES CALDERA



LOGGED BY J.B. HULEN & J.N. GARDNER

JULY 23 & 24 1988

DEPTH PHENIGITE	GRAPHIC LOGS										GRAPHIC GEOLOGY	NOTES, COMMENTS	DESCRIPTIONS	
	ALTERATION					FRACTURING	VEINING & VUG-FILL	QUARTZ	SERICITE	CHLORITE				PYRITE
	SERICITE	CHLORITIZATION	CHL	CAL	DISS. PYRITE									
200'														198.6-203.7': SANDSTONE, v. ft. brownish-gray, & subcrystalline w/ class of sandstone in a virtually identical matrix.
203.7'														203.7-205.2': As above, except breccia texture more apparent - this disruption appears to have occurred when the sandstone was wet.
205.2'														205.2-219.5': Bright gray-green, phenigic sandstone breccia: clasts of ft. gray-green to pinkish sandstone, angular to subrounded, embedded in a more prominently phenigic matrix; definite swirly texture, almost certainly soft sediment deformation. SCATTERED CLASTS OF MICROXLN. TO SPARRY CALCITE.
219.5'														* 212-219': More intense phenigic alteration, abundant carbonate clasts. * 213-219.5': Especially clay-rich (ft. gray-grn).
219.5-227.5'														219.5-227.5': SANDSTONE, gen. med-gr, w/ prominent soft-sediment deformation & distinctive "swirly" texture. VERY PHENIGIC. PHENIGITE ALN. (SEEMS TO PRE-DATE SOFT SED. DEFORMATION. THINK ABOUT SOFT DISRUPTION OF HOT LAKE SEDS.) * 223-225': Extremely clay-rich w/ sand-size particles of phenigite-altered clay.
227.5'														227.5-240.9': BRECCIA, coarse sandy, clay-rich; & to subround clasts of sandstone (v. rare med-gr, reddish sandstone (probably Aba Fm)).
240.9'														240.9-249': SANDSTONE, phenigic - v. colorful, prominent "swirly" soft-sediment deformation.
249-265'														249-265': BRECCIA, coarse, unsorted, clay-rich, sandy. Contains clasts of several different types of sandstone, including reddish & gray. Green clasts from the Permian Aba Fm.; diss. pyrite becomes more prominent. * @ 246': 2 MM. CLUSTER OF ACICULAR GRAY CEASE AXLS (STIBNITE). 1 PIECE * 70-85. * 258-259.6': Rich in tuff clasts.
265-268'														ORTHOSILICATE CLAST
268'														268-274.5': DENSELY WELDED FELSIC ASH-FLOW TUFF CLAST; FOLK HIGH- $\gamma$ , TRUNCATED AT CLAST MARGINS.
274.5-301.2'														274.5-301.2': SAME AS 248-268 FT., EXC. A FEW SCATTERED CHEST CLASTS - ALSO A FEW POSSIBLE FLUVIAL SS. STRINGERS & LENSES. * 297.5-299.5': CONCENTRATION OF DEFORMED, PHENIGITE-ALTERED CLASTS W/ VAGUE WISKY BORPERS. * 299.9-301.2': CLAST OF MED-GR. ARKOSIC SS.

DRILL HOLE VC-2B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.

LOGGED BY J. HULEN,  
J. GARDNER  
07/24/88



GRAPHIC LOGS										GRAPHIC GEOLOGY	NOTES, COMMENTS	DESCRIPTIONS	
DEPTH	ALTERATION					FRACTURING	VEINING & VUG-FILL	CHLORITE	PYRITE				OTHER
	SERICITE	MILK-CALCIFICATION	CHL	CAL	DISS. PYRITE								
300													* 304' → CLASTS ARE DOMINATED BY SANDSTONE & SILT-STONE. BEDDING IN CLASTS AT ALL ORIENTATIONS
													* 306.2': ONE CLAST W/ ABUNDANT ACCRETIONARY LA-FILL.
310													307.6' FAULT
													314.9' 314.9-319.6': SANDSTONE & SANDSTONE BRECCIA - "IN-TRANSFORMATIONAL" BY - SOME SOFT-SEDIMENT DEFORMATION; MED.-GR, IMMATURE VOLCANICLASTIC SS.
320													319.6' FLT
													319.6-320.8': BRECCIA, AS AT 304'. 320.5-321.7': RUBBLE-FALLT BRECCIA; STRONG CLAY
													321.7-327': BRECCIA, CLAY-RICH SANDY; PROBABLE DEBRIS-FLOW; DON. BY SANDSTONE CLASTS W/ MINOR TUFF & SPARRY CARBONATE.
330													327-331': SANDSTONE BRECCIA, AS ABOVE; CUT BY NETWORK OF CRENULATE ANASTOMOSING CHALCEPONY-CALCITE VEINLETS; CALCITE POST-PATE " VEINLETS UP TO 7 MM. WIDE.
													* 329.8': IRREGULAR PHENEGITIC BRECCIA BAND; INCORPORATES CLAST OF BRECCIA ABOVE.
													331-331.4': PHENEGITIC, SOFT-SEDIMENT-DEFORMED SANDSTONE. UNDISCUSSING UPPER CONTACT TRUNCATES OVERLYING VEINLETS.
340													331.4-352.9': BRECCIA, SANDY, PROB TUFFACEOUS, PROB DEBRIS-FLOW ORIGIN. LT GREENISH-GRAY, PROB INCORPORATES SERICITE & PHENEGITIC; MOST CLASTS ARE SANDSTONE SEVERAL TEXTURAL VARIETIES - SOME PERMIAN AEO FM, BUT MANY ARE FRAGILE CALDERA-FILL SANDSTONES; CLASTS ARE 2 TO SUBROUNDED UP TO AT LEAST 10 CM. DIAMETER; THE CALDERA-FILL SANDSTONE CLASTS APPEAR TO HAVE BEEN DEFORMED WHILE WET.
350													352.9-355': AS ABOVE, EXCEPT V. GRITTY-APPEARING
													355.9-358.0': AS ABOVE, EXC. POSS. MORE TUFFACEOUS MATRIX; BROWNISH, MORE COMPETENT "SWIRLY" TEXTURE CLASTS AVG. 1.2 CM. (UP TO 3 CM.) IN DIAMETER; TUFF CLASTS ABUNDANT.
360													358-368.5': BRECCIA, AS ABOVE (SIMILAR TO 331.4-352.9') A FEW CLASTS OF WHAT APPEARS TO BE THE UNDERLYING, IMMATURE SANDSTONE.
													368.5' ↙ MED.-GR.,
370													CONTACT DIP 20° 368.5-378.5': SANDSTONE, MOD. SORTED, "ALTBRECC-CATED" (1) SOFT-SEDIMENT DEFORMATION - SIMILAR TO 314.9-319.6'
													378.5'
380													DIP 60° 378.5-384.5': AS ABOVE, EXC. MORE MASSIVE WITH LESS EVIDENCE OF "ALTBRECCICATION" & SOFT-SEDIMENT DEFORMATION
													SCOURED? CONTACT DIP 20° 384.9-409.5': SANDSTONE BRECCIA. PHENEGITIC, OTHERWISE SAME AS 368.5-378.5'; PHENEGITIC CONCENTRATED IN MATRIX
390													
400													10.1' FAULT ZONE, 45°

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION VALLES CALDERA, NEW MEXICO

LOGGED BY HULEN & GARDNER  
 07/28/88

DEPTH	GRAPHIC LOGS										GRAPHIC GEOLOGY	VEINLETS	DESCRIPTIONS	
	ALTERATION					FRACTURING	VEINING & VUG-FILL	VEINLET FILLINGS						TRACE 1. MHAZ 2. MHAZ 3. STRONG
	SERICITE	SILICIFICATION	CHL	CAL	PISS. PYRITE			SILICATE	SERICITE	CHLORITE				
100														* 100-101': PINKISH CALCAREOUS SANDSTONE CLASTS W/ BEAUTIFUL PHENGITIC REACTION RIMS
110														0.1 FT ZONE IRREG. SLX 109'
120														* 109': CALCITE-CEMENTED RUBBLE
130														409-490': BRECCIA, CLAY-RICH, SANDY UNSORTED, PROBABLY OF DEBRIS-FLOW ORIGIN; PHENGITIC CLASTS OF REDDISH, LIGHT GRAY, & GREENISH-GRAY SANDSTONE, PREDOMINATE - SUBORDINATE PRECAMBRIAN GNEISS, SILTSTONE & RARE CARBONATE; CLASTS ARE ANGULAR TO SUB-ROUNDED, SOME AMOEBOID (APPEARS TO HAVE BEEN INCORPORATED & DEFORMED WHILE WET); CLASTS UP TO AT LEAST 20 CM IN DIAMETER; AB FM SS. CLASTS ARE LOCALLY CUT BY CALCITE VEINLETS - PRE-BRECCIA
140														
150														
160														* 181-181.8': PHENGITIC (GRAY-GREEN) & LT. GRAY CALCAREOUS MED.-GR. SS. ABUNDANTLY VEINED WITH CALCITE-CHALCEDONY, SUB-// TO BEDDING
170														* 186-186.7': LITHIC-RICH, LT. GRAY TUFF CLAST (HWAFT?)
180														
190														* 444-444.5': PYRITE VEINLETS, IRREG. DISCONTINUOUS, <1 MM. WIDE, CUTTING BOTH CLASTS & MATRIX.
200														
210														
220														
230														
240														
250														
260														
270														
280														
290														
300														
310														
320														
330														
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350														
360														
370														
380														
390														
400														
410														
420														
430														
440														
450														
460														
470														
480														
490														
500														

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 LOGGED BY HULEN & GARDNER  
 07/29/88

DEPTH	GRAPHIC LOGS											GRAPHIC GEOLOGY	TR. TRACE 1. WEAK 2. MOD. 3. STRONG	VEINLETS	DESCRIPTIONS			
	ALTERATION					FRACTURING	VEINING & VUG-FILL	VEINLET FILL			VOL. FILLINGS							
	SERICITE	SILICIFICATION	CHL	CAL	DISS PYRITE			QUARTZ	SERICITE	CHLORITE						CALCITE	PYRITE	
500																		
505																		
510																		
520																		
530																		
540																		
550																		
560																		
570																		
580																		
590																		
600																		

DRILL HOLE VC-28 (FIELD LOG)  
 LOCATION VALLES CALDERA, N. MEXICO

LOGGED BY J. HUIJEN  
 07/25-07/31/88

MEM. STAIN/CEMENT

DEPTH	GRAPHIC LOGS											GRAPHIC GEOLOGY	NOTES CORRECTIONS	DESCRIPTIONS
	ALTERATION					FRACTURING	VEINING & VUG-FILL	VEINLET & PHASES						
	SERICITE WMS	SILICIFICATION SLS	CHL CS	CAL WMS	DISS. PYRITE WMS			QUARTZ	SERICITE	CHLORITE	CALCITE			
600'														* 601-602.9': FRACTURE W/ OBLIQUE SLIK, DIP 65-70° W/ PYRITE & QTZ * 603': 1-6 MM QTZ VEIN W/ DP OF 60° (TO BASE AT 609.6'): IRREG. TO SUBROUNDED CLOTS OF DISS. PYR. AVE. 1 CM (< 2 CM) DIAMETER - PROBABLY REPLACED LITHICS.
610'														* 606': FLOW UNIT CONTACT DIP W 40° 609.6-611.8': LITHIC-RICH, WELL-BEDDED, PROBABLE SURSE DEPOSIT; BETTER BEDDING TOWARD BASE 611.8-619': FELSIC ASH-FLOW TUFF, WEAKLY TO MOD. WELDED; APPEAR TO BE A FEW SCATTERED VAPOR-PHASE CAVITIES, PARTIALLY LINED TO FILLED WITH SERICITE & PYRITE.
620'														619-624': AS ABOVE, ETC. MOD. WELDED 624-629.8': AS ABOVE, BUT MOD. - DENSELY WELDED * 624-629.8': SCATTERED, SOOXY GRAY "SOAK" VEIN-ETS, LOOK LIKE V.V. EXLN. PY OR MO <sub>2</sub> - ALSO SCATTERED, IRREGULAR CLOTS OF SAME
630'														* NOTABLE INCREASE IN SILICIFICATION AT W 627 * 631': 1 MM ILLITE (SER.) VEINLET X-CUTS GRAY VLS. (SOME ILLITE DEFINITELY LATE-STAGE)
640'														* 640-644': INTENSE STACKWORK QTZ-VEINLETS MANY VERY STEEPLY-DIPPING
650'														
660'														
670'														669-674': FELSIC ASH-FLOW TUFF XL-RICH (25% QTZ PHEN. CRYST-BEARING, AS ABOVE EXCEPT ABUNDANT VAPOR-PHASE CAVITIES - "SHELL-WITHIN-SHELL" LITHOPHYSAE. THESE ARE SILICIFIED & PARTIALLY LINED WITH ELH. QTZ VLS. IN BULK OF ROCK - MOD. QTZ-SER. ALTN. SPARSE QTZ-SER-PY VEINLETS < 1 MM WIDE.
680'														674-688': AS ABOVE, EXCEPT DENSELY WELDED W/ DISTINCT EULITAZITIC TEXTURE; MANY LARGER FIAMME, SLIGHTLY GRAY-GREEN, SELECTIVELY PYRITIZED; FELDSPARS ONLY PARTIALLY ETCHED, SERICITIZED
690'														688-729': SAME AS 624-668' * 688-694': MOD. ABUND. PYRITE, AS IRREG. CLOTS & STRINGERS UP TO 2 CM DIA. * 690-691': IRREG. STRINGERS OF DK. GRAY SOOXY-APPEARING MINERAL (MO <sub>2</sub> ? PYRITE?) * 695-697': AS ABOVE
700'														

DRILL HOLE VC-28 (FIELD LOG)  
 LOCATION VALLES CALDERA, N. MEXICO.

LOGGED BY J. HULEN  
 07/31/88



DEPTH	GRAPHIC LOGS											GRAPHIC GEOLOGY	NOTES, COMMENTS	DESCRIPTIONS
	ALTERATION				FRACTURING	VEINING & VUG-FILL	VEINLET & VUG PHASES							
	SERICITE	SILICIFICATION	WMS	WMS			VEINLET	VUG-FILL	VEINLET	VUG-FILL				
800'												LEACHED, VUGGY SILICIFIED		
810'												810' FRY. DIP 60 & 65° HYDROTHERMAL BRECCIA - FAULT, DIP 70°	810-814': WEAKLY- TO NON-WELDED ASH-FLOW TUFF; EQUIVALENT OF OVERLYING ROCK * 811-814': QTZ-SER ALTN. INCREASES * 813-813.5': SHEARED, FRACTURED, VERY HEAVILY SERICITIZED.	
820'												LEACHED, VUGGY, ABUNDANT QUARTZ CRYSTALS	814-817': MOD. WELDED ASH-FLOW TUFF; OTHERWISE SAME AS ABOVE. 817-819.5': HYDROTHERMAL BRECCIA DIKE AT 70° 819.5-820': EXTREMELY VUGGY ETCHED SILICIFIED, DENSELY WELDED ASH-FLOW TUFF; EHLERDRAL PRISMATIC QTZ. XLS. UP TO 1 CM IN DIA. IN THE VUGS * 819.5-820.5': FAULT, DIP 70°	
830'													828' 828-862.8': DENSELY WELDED, CRYSTAL-RICH, FELSIC ASH-FLOW TUFF; FRACTURED, SILICIFIED, QTZ-SERICITIZED * 824.5-847': FRACTURES ARE DOMINANTLY HIGH- $\angle$ ; MOST DIP FROM 60-70° (FULL RANGE IS 45° TO VERTICAL).	
840'												LEACHED, VUGGY	* 828': PSEUDOMORPHIC "SHELLS OF PRISMATIC QTZ, MATTED TO FORM HOLLOW RHOMBOHEDRONS; THESE ON QTZ-SER FRACTURE COATING.	
850'												1.5 X 0.5 CM QTZ XLS ON 75° FRAC/VHNT	* 847-852': 90% OF FRACTURES DIP > 70°	
860'												CONACTION FOLN. DIP 13 0-50°		
870'												862.8' 862.8-869.5': MOD. WELDED FELSIC ASH-FLOW TUFF, OTHERWISE SAME AS 828-862.8'; ROCK IS INTENSELY FRACTURED & ETCHED/LEACHED - A ZONE OF DISSOLUTION POROSITY; STRONG PREFERRED ORIENTATION OF FRACTURES - MOST ARE > 70° IN DIP; FRACTURE PLUS SOLUTION POROSITY IN THIS ZONE LOCALLY > 15% (AVG. W 10%). * VEIN/VUG MINERAL PARAGENESIS THIS ZONE IS QTZ + SER + PRISMATIC QTZ VUG + LATE SER.		
880'													869.5-912': MOD.-DENSELY WELDED, XL-RICH, FELSIC ASH-FLOW TUFF * 881-898': ZONE OF STRONG FRACTURING, SILICIFICATION & VEINING - SOME ETCHING BUT NOT AS INTENSE AS ABOVE; ABUNDANT QTZ-SER + PY VEINLETS W/ EHLERDRAL QTZ. XLS COMMONLY UP TO 10MM IN LENGTH; MOST FRACTURE & VEINLETS NEAR-VERTICAL.	
890'												ABUNDANT QUARTZ VEINLETS MODERATE SOLUTION POROSITY.	* 882.5-883.5': W 10MM-WIDE, WISY QTZ VEIN WITH XLS. UP TO 15 MM LONG; EHLERDRAL, PRISMATIC.	
900'														

DRILL HOLE VC-2B (FIELD LOG)  
LOCATION VALLES CALDERA, N. MEXICO



LOGGED BY J. HULEN  
J. GARDNER  
08/14/88



GRAPHIC LOGS												VEINLETS	DESCRIPTIONS		
DEPTH	ALTERATION					FRACTURING	VEINING & VUG-FILL	VEINLET PHASES						GRAPHIC GEOLOGY	
	SER.	SILICIFICATION	CHL	CAL	DISS PYRITE			QUARTZ	CLORITE	CALCITE	PYRITE				RHODOCHR.
900'														STRONG ETCHING, SOLUTION POROSITY	* 905-912': STRONGLY LEACHED, ETCHED, W/ ABOUT 7% FRACTURE + SOLUTION POROSITY.
910'														912'	912-927': FAULT ZONE; ABUNDANT GOUGE & BRECCIA + FAULTING POST-DATES ONE EPISODE SILICIFICATION & QTZ VEINING - ALSO A SECOND EPISODE OF SILICIFICATION RESULTING IN DEPOSITION OF SUB-MM-SIZE PRUSY QTZ XLS. ON SURFACES OF BRECCIA CLASTS
920'														FAULT ZONE (BOTH PRE- & POST- FAULTING QTZ XL DEPOSITION)	
930'														927'	927-929': DENSELY WELDED, XL-RICH FELSIC ASH-FLOW TUFF, STRONGLY SILICIFIED, FRACTURED
														929'	929-934': FAULT ZONE AS ABOVE, EXCEPT LESS INTENSE RUBELIZATION
														RHODOCHR-SITE	** RHODOCHR-SITE(?) OR MD-RICH CALCITE APPEARS AT 927' - DESCRIPTION BELOW
															934-939': SAME AS 927-929': VARIABLE-INTENSITY FRACTURING, SILICIFICATION; ROCK IS LT-MED. GRAY & HAS A FLINTY APPEARANCE; VARIABLY LEACHED/ETCHED WITH ELIHEDRAL QTZ CRYSTALS DEPOSITED IN OPEN SPACES.
940'															** RHODOCHR-SITE TO 940'; ELIHEDRAL (RHOMBIC) TO BOTRYOIDAL, LT. PINK, COATING PRISMATIC QTZ XLS.
															* PARAGENESIS THROUGHOUT THIS ZONE APPEARS TO BE QTZ + SER + PY, THEN PRISMATIC QTZ XLS, THEN RHODOCHR-SITE, THEN LATE STAGE ELIH. PY W/ WHITE SERICITE.
950'															
960'														959' FAULT	959-961': FAULT ZONE; RUBBLE, ABUNDANT SLICKENSIDES; MANY SLX HAVE 60° DIP; MOVEMENT IN PART POST-DATES ALN. & MINERALIZATION.
														961'	
														963'	961-963': SAME AS 934-939'
														FAULT ZONE	963-971.5': SAME AS 959-961'
970'														971.5'	971.5-1020': MOD. WELDED, XL-RICH, FELSIC ASH-FLOW TUFF, LT. SLIGHTLY PURPLISH-GRAY WITH GRAYISH-GREEN FLAMME; TUFF CONTAINS ~ 9% LITHICS; ROCK HAS PITTED APPEARANCE DUE TO ETCHING OF FELP SPARS; CHLORITE APPEARS - CONCENTRATED IN FLAMME; A FEW LG. PY (XLS) CLOTS UP TO 8 MM. DIA.; WIDELY SCATTERED PY VEINLETS < 1.5 MM. WIDE.
980'														CONG. POL. DIP 70°	
														FRX DIP 60°	
990'														BLADED CALCITE IN VEINLET	
															* 994': CONCENTRATION OF SANDSTONE LITHIC FRAGMENTS APPEARS TO HAVE LOCALIZED FRACTURING.
1000'															

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.

LOGGED BY J. HULEN  
 J. GARDNER  
 08/10/88

GRAPHIC LOGS												NOTES COMMENTS	DESCRIPTIONS	
DEPTH	ALTERATION					FRACTURING	VEINING & VUG-FILL	VEINLET FILLING	FLYASH	GLASS	GRAPHIC GEOLOGY			
	FER	HAUK	CHL	CHL/CLC	DISS PYRITE									
	WMS	NMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS			
1000'													MOD. WELDED, KL-RICH ASH-FLOW TUFF, AS ABOVE. Ch. preferentially replaces some lithic fragments & some framme.	
1010'												ABO LITHICS	clast % increases below 1006 ft. (to 5-7%); almost all appear to be derived from the Abo Formation -- red siltstones & sandstones, lt. gray-green siltstones -- some red & gr. varieties. These avg. $\approx 5$ mm, $\approx 1$ dia locally up to 100 mm -- some well-bedded.	
												comp. fol. dip $\approx 10^\circ$	paragenesis among vein minerals is chlorite + sericite, pyrite, calcite	
												1014.5'		
												1018.0'	*1014.5-1018': UNIT becomes more densely welded, darker gray-green.	
1020'														
													*1022.5-1030': Lithic increase to 8-15%, still dominantly Abo Formation, most of which are intense brownish-red coloration, some med. gray-green. Some of these chips are platy/tabular (bedding influence?)	
1030'												1030'	*1030-1055.4': V. LITHIC-RICH NW? ASH-FLOW TUFF varies from 50-70% lithic, 5' to subrounded up to 1/2 cm dia, avg. $\approx 1/8$ cm; subequal amount of red-brown hematitic Abo Fm. siltstone, sandstone & med.-de. gray-green chloritized Abo equivalent (some clasts both red & green) pre-brecciated chloritization; small clast of Fe granite.	
												CONT. dip $\approx 10^\circ$	1032.5'	1032.5-1032.7: Mod. densely welded kl-rich ash-flow tuff, as above; some clasts selectively pyritized.
1040'														
												FLOW UNIT DIP $\approx 10^\circ$	*1044.6': CONTACT between lithic-rich band (0.5') & lithic-poor ash-flow tuff.	
												FRAC. DIP $\approx 10^\circ$		
												COMP. fol. dip $\approx 10^\circ$		
1050'												1052.7-1064'	[BRECCIA] probably a lithic-rich pyroclastic flow; $> 70\%$ to subrounded lithic fragments up to 25 cm dia, avg. $\approx 2$ cm, predominantly matrix-supported. Clasts are alt. 50% brick red-brown Abo Fm. shale mudstone, siltstone & 50% are lt.-med. gray green siltstone & sandstone, $\approx 20\%$ med.-crs. gray, lt. gray to greenish-gray sandstone, some of which is very well-bedded; $\approx 5\%$ non-welded to mod. welded ash-flow tuff; MATRIX is variable from lt. gray-greenish-gray to phenocryst-bearing ash-flow tuff; some matrix appear to be a finely comminuted version of the larger clasts. Many of the shale mudstone siltstone clasts are highly and apparently plastically deformed; both pre- & post-breccia calcite veining apparent.	
												PRECOMB. GRANITIC CLAST	1064-1079'	lt.-med. gray siltstone clast w/igsaw puzzle texture; post- a single, larger clast disrupted post-depositionally.
1060'												ABO & MADERA CLASTS	1064-1079': INCREDIBLE, VARIEGATED, RED & GREEN BRECCIA. Angular to subangular highly irregular clasts of brick red to gray-green siltstone, sandstone, & mudstone in a mudstone matrix; purplish-gray, ribbon clasts of Madera granite, mostly $> 1$ cm dia, many of the clasts are breccia themselves.	
1070'													1079-1088.5': BRECCIA, AS ABOVE w/ distinctive "fluidal" texture; dominantly Abo silt. & ss. clast, as above much contortion of clasts	
												1089.5'	1088.5-1089.5' EX. as above but app. a welded AFT matrix; $\approx 25\%$ clasts, still mostly Abo Fm. silt. & ss. mudstone; fluidal textures in matrix	
1080'													1089.5-1101.0: densely welded; crystal-rich, large ash-flow tuff -- appears to be some relict glass; alteration definitely diminishes. 7-8% lithic frag.	
1090'												comp. fol. dip $\approx 10^\circ$		
1100'												comp. fol. dip $\approx 10^\circ$		

DRILL HOLE VC-2B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM



LOGGED BY J. HULEN  
J. GARDNER

08/12/88



DEPTH	GRAPHIC LOGS										NOTES COMMENTS	DESCRIPTIONS	
	ALTERATION					FRACTURING	VEINING & VUG-FILL						GRAPHIC GEOLOGY
	PER	SILICIFICATION	CHL	COB	DISA PYRITE		QUARTZ	CHLORITE	CALCITE	PYRITE			
1100													1101.1-1101.9: concentration of framme "sinking" of v. tuffaceous clots into underlying tuff. v. white- darker, glassier portions bleached appearing
1100													1101.1-1101.9: concentration of framme 1101.1-1101.9: NW, v. lithic-rich AFT, 60% ± to subvol. 1101.1-1101.9: NW, v. lithic-rich AFT, 60% ± to subvol. 1101.1-1101.9: NW, v. lithic-rich AFT, 60% ± to subvol.
1110													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1120													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1130													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1140													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1150													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1160													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1170													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1180													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1190													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.
1200													1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol. 1108.2-1109.2: NW, v. lithic-rich AFT, 60% ± to subvol.

DRILL HOLE VC-10B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM



LOGGED BY J. HULEN & J. GARDNER

08/12/88

DEPTH	GRAPHIC LOGS											NOTES COMMENTS	DESCRIPTIONS				
	ALTERATION					FRACTURING	VEINING & VUG-FILL	VEINLET & VUGS						GRAPHIC GEOLOGY			
	FER.	SILICA FICATION	CHL	DISS. PYRITE	QUARTZ			SERICITE	CHLORITE	CALCITE	PYRITE				FLUORITE		
1200'																	1197.7 - 120.4 FT. COMPLEX BRECCIA ZONE: clasts of pyritic sandstone(?) sandstone & AFT embedded in a composite matrix of pinkish, med.-sorted sandstone & H. greenish-gray MVAFT. 60-70% clasts up to at least 10 cm. diol. matrix (both tuff & sandstone) have been squeezed, deformed.
1210'																	1201.8-1202.9: clean, well-sorted, white ss. intruder breccia consisting of pink sandstone in a sparse, H. greenish-gray matrix. 1201.8-1202.9: ss breccia; pink, sorted sandstone(?) unneededly invaded by stringer of H. greenish-gray ash-flow tuff * 1201.8-1202.9 - 0.5' of the tuff matrix material, as described above 1207-1220: pink to H. gray-green, well-sorted, med-grn "sandstone". Rarely, soft-sediment deformation & intraformational breccia.
1220'																	* 1210.8-1211.5: zone of more intense, mottled chloritization * @ 1217: v. irrad. 2-3 cm band of gray green ash-flow tuff, collapsed contacts, entrained clasts of sandstone which it intrudes. * @ 1221 irreg. scour-like contact, modified by shearing 1221: v. xl-nca (40-45%) DWAF, dk. gray, locally range glassy black shards. * chl v. int. post-date ser-qtz-chl v. int.
1230'																	* shards pty etched below 1240, but still fresh glass. * 1237: fluorite-ser-chl-qtz v. int. areas also: rare but not fluorite-free all have H. gray-green/chl-ser. selvages. * @ 1245: FLUORITE, APPLE GREEN & white vein, 10 mm. w/ selvages of ser-qtz-chl (H. gray green). (GRADUALLY BECOMES GRANOPHYRICALLY RECRYSTALLIZED)
1240'																	
1250'																	
1260'																	
1270'																	
1280'																	
1290'																	
1300'																	

DRILL HOLE VC-7B (FIELD LOG)  
LOCATION \_\_\_\_\_

LOGGED BY J. HULEN & J. GARDNER

Aug. 13, 1988

DEPTH	GRAPHIC LOGS												NOTES COMMENTS	DESCRIPTIONS	
	ALTERATION					VEINLET & VES. FILL.	VEINLET & VES. PHASES	GRAPHIC GEOLOGY							
	SER	SILICIFICATION	CHL	PIES	PYRITE										
1300'														LOT 2W1	<p>DN. V-RICH FELSIC ASH-FLOW TUFF AS ABOVE. SPINDRAGE &amp; FINE-TEXTURED SILICIFIED-APPEARING GRANULITES BOTH HT &amp; FLOW. ALL COATED/LINED WITH CHL &amp; LATER ILLITE</p> <p>W 45% XLS. AVG. 1.5-2 MM. (10% QTZ)            QTZ PHENOS ARE BIPYRAMIDAL V. COMMONLY            * WELDING POSS. DIMINISHING SLIGHTLY</p>
1310'															<p>+ 3/4" of the felsic lithics appear flow-banded (poss. rhyolite)</p> <p>* NOTE: COMMONLY A LIGHT COATING OF ILLITE ON CHLORITE</p> <p>@ 1314.5': 5 CM X 3 CM LITHIC - DRAFT,            * SOME CHLITEN. OF FELDSPARS (TR.) - LIGHT GREENISH CAST &amp; SPECIES</p>
1320'															<p>@ 1320.5' CHL-CALCITE VEINLETS APPEAR - UP TO 10 MM. WIDE - CALCITE IS BLADED (DEP. FROM BOILING SOLNS. "FISH-SCALE" CALCITE</p> <p>@ 1327' FISH-SCALE CALCITE VEIN W/D = 15 X &lt; 1.0 MM. BLADES</p> <p>* CALCITE APPARENTLY CONFINED TO VEINLETS.</p>
1330'															<p>* CALCITE WILTS. DIP W 90-45°</p> <p>* CHLORITE IS THE DOMINANT VEINLET PHASE - ITS CLASSICAL SPINACH-GREEN COLOR, COMMONLY LIGHTLY COATED W/ILLITE (PEARLESCENT SHEEN)</p>
1340'															
1350'															<p>W 1343-1346': HYDROTHERMAL EX; MATRIX-POOR; 2 CLASTS SET IN A MATRIX OF CHLORITE-SERICITE-CALCITE; IN SOME PLACES CAL IS EARLY ELSEWHERE LATE; HEAVILY FRACTURED (HYDROFRAC?) ON EITHER SIDE (L OR VEINED)</p> <p>MATRIX VEINLETS DOMINANTLY HIGH-ANGLE TO VERTICAL</p> <p>1346-1348': DENSELY WELDED ASH-FLOW TUFF, AS ABOVE</p> <p>* 1351-1392.5' BANDED CHL-CAL VN @ 75° DIP INTERIOR IS BLADED CALCITE</p>
1360'															
1370'															<p>* @ 1368.9' FIBRIFORM 80 X 15 MM (W 35° PHENOCRYSTS) PARALLEL PHENOCRYSTS 2° THIN MATRIX (2° VS 40°)</p> <p>* @ 1367.8' 40' CM BRECCIA FRAGMENT (A CLAST WHICH IS BRECCIA)</p> <p>* 1371-1392: mod. abund. calcite veinlets &amp; breccia filling w/chlorite &amp; sericite selvages - "jigsaw puzzle" textures common - probably a hydraulic fracture network - supporting this interpretation: calcite is bladed</p>
1380'															<p>* many of these chl-cal veinlets are delicately banded at outer margins. see below</p>
1390'															<p>* @ 1391.5': SEE NOTE AT LEFT</p> <p>* GRANULAR TEXTURE GIVES WAY TO CAPTOLIN. STONY MATRIX @ 1393'</p>
1400'															

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 -35- NEW MEXICO

LOGGED BY J. HULEN & J. GARDNER  
 AUGUST 14 & 15 1988

GRAPHIC LOGS

DEPTH	ALTERATION										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS
	SER	SILICIFICATION	CHL	CPH	DIS. PYRITE	FRACTURING	VEINING & VES-FILL.	QUARTZ	VEINLET FELTIC	GLAUCOPHANE			
	WMS	XMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS			
1400													
1410													<p>② 1405.5': COMPLEX HYDROTH. BRECCIA W/ MSTRK ALT. TO CHL-CAL SER(?) ANASTOMOSING VEINLETS OF CHL-SER, PALE LT. GRAY-GREEN; HIGHLY VENEED ON EITHER SIDE OF THIS BRECCIA ZONE.</p> <p>* 1407.7-1409.7': LOCAL VERTICAL undulating fracture surface w/ horizontal slickensides.</p> <p>* 1414.5-1416.6': HIGHLY FRACTURED ZONE POSS. TECTONIC REFR. OF HYDROTH/HYDROTH. EX.; MATRIX BETWEEN CLASTS IS CEMENTED W/ CHL, CAL, V. MINOR SER, TR.</p> <p>* 1416.6-1420.7': AS ABOVE EXC. VEINLET INTENSITY DIMINISHES. STILL SMALL STRINGERS OF HYDROTHERMAL BRECCIA, LOCALLY CEMENTED WITH CHL-CAL.</p>
1420													<p>COMP. POS. DIP W 150</p> <p>* BELOW 1420.7, ROCK IS LESS BLEACHED, FIAMME (&amp; SHARDS MORE PROMINENT)</p>
1430													<p>FISHSCALE CALCITE VENEED W 150 DIP</p> <p>* 1428.7-1441': ZONE OF MORE INTENSE CHLORITIZATION, "BLEACHING" (SERICITIZATION), STOCKWORK CHL &amp; CAL &amp; TR. PY &amp; TR. SER. VENTS; LOCAL EVIDENCE OF HYDRAULIC FRACTURING; MUCH OF THE CALCITE IS PLATED HABIT (EVIDENCE OF BOILING?)</p>
1440													
1450													<p>1449-1454': irregular undulating dikes &amp; stringers of densely welded ash-flow tuff injected into some, apparently v. hot &amp; plastic injection; dikes &amp; stringers are light gray, fractured host rock is dark gray &amp; densely welded, possibly some relict glass, but certainly partially devitrified. SCRATCHES W/ KNIFE BLADE; HYDRAULIC FRACTURING IND. BY CHL-CAL &amp; SER. VEINING CONTINUES AS ABOVE. SOME SERICITE IS LATE-STAGE, COATS PLATED CALCITE KLS.</p>
1460													<p>IRREGULAR FLOW UNIT CONTACT DIP 45</p> <p>1461.8-1466': NON-WELDED LITHIC-RICH, FELSIC APT 35-40% LITHIC FRAGS UP TO AT LEAST 7 cm. dia (avg. v. 1.5 cm); rock is lt. grayish-gray, punky; most lithic clasts are porphyritic andesite</p> <p>* 1465-1466': highly disturbed zone w/ clasts of bedded tuff (poss. disrupted surge deposit - fallout)</p> <p>1466-1470' weakly to mod. welded APT, 7% lithics locally contorted compaction foliation</p>
1470													<p>disrupted surge? dip v 60</p> <p>contact irreg. dip avg. v 60 (scoured?)</p> <p>14705-1488': NON-WELDED, LITHIC &amp; PLINICE-RICH FELSIC ASH-FLOW TUFF, 30-35% LITHIC FRAGMENTS PREDON. APLINIC &amp; PROTIC. INTM-COMP. VOLCANIC EX FRAGMENTS - avg. v. 1 cm. dia.; rx is lt. gray-green, punky porous.</p> <p>* ② 1479.2': 1 cm. fallout?; bard, dip n 45, slightly deformed.</p>
1480													<p>DIP 45</p> <p>1488-1489.5': MOD. WELDED, XL-RICH (25-30%) APT, relictified lt. purplish-gray - welding increases w/ depth.</p> <p>1489.3-1525': DWAPT, XL-rich (40%); upper 1 ft. "MW" lt. purplish-gray, but grades downward into dark purplish-brownish gray; shard &amp; flammé clearly visible, darker than matrix; calcite, weakly replaces feldspar (also weak chlorite)</p>
1490													<p>IRREG. (SCOURED?) CONTACT</p> <p>FLOW UNIT CONTACT DIP n 15</p> <p>FRAC. HORIZ. SURF. IND. BY (some hem) on stir</p>
1500													

DRILL HOLE VC-28 (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,

LOGGED BY J. HULEN & J. GARDNER  
 AUG. 15, 1988  
 16 & 17

DEPTH	GRAPHIC LOGS											NOTES COMMENTS	DESCRIPTIONS
	ALTERATION					FRACTURING	VEINING & VUG-FILL.	VEINLET PHASES			GRAPHIC GEOLOGY		
	SER	PHILIC FUSION	CHL	CHL	DISS. PYRITE			QUARTZ	PERCITE	CHLORITE CALCITE			
1570													<p>* chards &amp; flame readily visible; FELDSPAR PHENOS SLIGHTLY PINKISH - PROBABLY MICROBRECCIA</p> <p>EXTREMELY DENSELY WELDED VL-RICH ASH-FLOW TUFF AS ABOVE - COULD BE CALLED A VITROPHIRE; 45% KLS. (X-12% Qtz REMAINDER SSP, TR. MAFIC); MATRIX IS CLAYY DARK PURPLISH-TO-BROWNISH-GRAY - almost certainly contains abundant relict glass - locally cannot scratch w/ penknife.</p> <p>* INJECTED-APPEARING BELOW 1504.8, BUT FINE-EXTEND RIGHT ACROSS "INJECTED" ZONES (SELECTIVE DEVITRIFICATION).</p> <p>* 1506-1512: ZONE OF STRONG FRACTURING (HYDROTHERMAL) hydroth. b/c of v. steep dip (near-vertical) - open fracture w/ fishscale calcite/chl. veinlets vug-filling; some 1.5cm-wide open fractures</p> <p>BLADED CALCITE VEINLETS CONTINUE</p>
1510													<p>STRONG FRACTURING, PROBABLY HYDRAULIC</p>
1520													<p>1525-1528.5: ALTERED HYDROTHERMAL BRECCIA "JCSAN PUZZLE" TEXTURES VERY PROMINENT; CHLORITE-CALCITE-ROCK FLOW MATRIX, OPEN FRACS &amp; VUGS COMMON, SOME FILLED OR LINED WITH BLADED CALCITE.</p> <p>1528.5-1532: DENSELY WELDED ASH-FLOW TUFF AS ABOVE CAL-CHL VEINLETS PERSIST.</p> <p>* NOTE: BELOW 1532 FT. ROCK IS EXTREMELY HARD (CANNOT SCRATCH W/ PENKNIFE).</p> <p>BLADED CALCITE VEINLETS CONTINUE (CHLOR. SELVAGES)</p>
1530													<p>1549-1552.5: ZONE OF PARTICULARLY INTENSE hydroth. &amp; HYDRAULIC FRACTURING, chl-cal. breccia spaces filling &amp; veining &amp; some rock flow/microbreccia</p>
1540													<p>AS ABOVE</p> <p>* @ 1576: ZONE OF INTENSE FRX, bctm, fishscale calcite, lightly coated w/ thin ff. gray-green phenite</p>
1550													<p>AS ABOVE</p> <p>* 1575-1579: ROCK IS INVADIED BY AN ANASTOMOSING NETWORK OF TIGHT ROCK FLOW/MICROBRECCIA VEINLETS - THESE LOCALLY OPEN, INFILLED WITH BLADED CALCITE.</p>
1560													<p>AS ABOVE</p>
1570													<p>AS ABOVE</p>
1580													<p>AS ABOVE</p>
1590													<p>AS ABOVE</p>
1600													<p>AS ABOVE</p>

DRILL HOLE VC-2B (FIELD LOG)

LOCATION SULPHUR SPRINGS  
VALLES CALDERA, NM.



LOGGED BY J. HULEN & J. GARDNER

AUGUST 17, 1968  
#10

GRAPHIC LOGS										NOTES, COMMENTS	DESCRIPTIONS	
DEPTH	ALTERATION					VEINING & VUG-FILL.	VEINLET & VUGS					GRAPHIC GEOLOGY
	QUARTZ SERICITE	SILICIFICATION	CHL	DISS. PYRITE	FRACTURING		QUARTZ SERICITE	CHLORITE CALCITE	PYRITE			
1600												<p>DEVELOP WELDED VL-RICH FELSIC ASH-FLOW TUFFS AS ABOVE W/ ZEPHYRUS PHENOCRYSTS. DENSE, HARD FLINTY. CANNOT SCRATCH W/ PEN-KNIFE; SCATTERED CH-CAL VUGS.</p> <p>* 1600.7': n. 7 X 2 cm. flow-banded, spherulitic, white rhyolite lithic clast.</p>
1610												<p>(EXTREMELY HARD)</p> <p>* 1614 - ROCK BECOMES MOTTLED - PROBABLY MORE DEVITRIFIED OR COARSE-CRYSTALLINE DEVITRIFICATION PRODUCTS</p>
1620												<p>COMP. FOL. DIP n 18°</p> <p>* 1625.5-1628: MOD. INTENSE FRACTURING w/ CHL-CAL VEININGS.</p>
1630												<p>TECTONIC FRACTURING</p> <p>(LITHICS INCREASING)</p>
1640												<p>1639-1640: MWAFT, H-met purplish- to brownish-gray w/ 10-12% LITHICS UP TO 2 cm - mostly porphyritic andesite some rhyolite, some sandstone ser. &amp; chl. increasing TO MOD. WELDED.</p> <p>1642-1644: WEAKLY WELDED (AS ABOVE OTHERWISE) 20-25% LITHICS. FELDSPARS ARE ETCHED, PARTIALLY SERICITIZED. DOMINANTLY (20%+) LITHICS ARE VARIABLY CHLORITIZED PALIZA CANCER ANDESITE.</p>
1650												<p>1644-1650.9: N. HIGH-ANGLE FRACTURE, locally w/ hem.-stained horizontal slickensides</p> <p>1647.2-1648.5: HYDRAULIC FRACTURES, HYDROTH. BK. DICE, 1 CM. WIDE</p> <p>AS ABOVE</p> <p>1672-1682: ROCK BECOMES MOD. WELDED, OTHERWISE SAME AS ABOVE.</p>
1660												<p>1698-1700: DENSELY WELDED, LITHIC-RICH, FELSIC ASH-FLOW TUFF</p> <p>* rock has become densely welded but still flakey. lithic-rich (10-15%)</p> <p>* below 1644: rhyolite lithics increase to w 35% of total lithics.</p>
1670												<p>ROCK IS VERY HARD, DENSE, "FLINTY"</p> <p>COMP. FOL. DIP n 10°</p>
1680												<p>CAL-CAL-SER-FL. VN.</p> <p>* 1679.2': EMBLEN 3 DM. FLUORITE xls. IN CAL-CAL-SER VNIT - CALCITE IS still bladed.</p>
1690												
1700												<p>* BEGINS TO BECOME MOD. WELDED BELOW 1682'</p> <p>* 1697.8: DTS. RETURNS TO VERTIC - early - small prismatic xls.</p>

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 NEW MEXICO

LOGGED BY J. HULEN & J. GARDNER  
 AUG. 18, 1968  
 19'



GRAPHIC LOGS

DEPTH	ALTERATION											GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS	
	SER	SILICIFICATION	CHL	CAR	DISS PYRITE	FRACTURING	VEINING & VUG-FILL	STASZ	SERICITE	CHLORITE	CALCITE				ANITE
1700													<p>1700-1705: CAL-CAL-SER-Qtz-FL VNET, 45° DP</p>		
1710													<p>1706-1744.8: MW LITH. rich ash-flaw rich, H-med. purplish-gray; mottled toward upper contact and lighter color below; flame and some lithics selectively chloritized, vernet altn. intensity increases &amp; decrease in welding.</p> <p>• @ 1706 - appearance of brick red hematitic oxidized porphyritic volcanic rock.</p> <p>(NOTE): BELOW 1775, rock is more bleached-appearing w/ pinkish-gray; chloritization increases, feldspars etched, partially sericitized.</p> <p>• diss. py &amp; py in vnts. re-appears @ n 1710</p>		
1720													<p>FRAC. DIP 55°</p> <p>FRAC. DIPS. 63° &amp; 70-70°</p>	<p>* habit of calcite changes - more solid, platy, intergrown with</p> <p>• fsp. etching increases below 1726'</p> <p>* ROCK IS NOW LT. PINKISH-GRAY W/ DISTINCT LT. GREENISH-GRAY FLAME; LITHICS DECREASING.</p>	
1730															
1740														<p>• 1739 - 2 CHL-SERICITIZED PERLITE CLASTS, CELLULAR STRUCTURE CLEARLY PRESERVED; POSSIBLE OPALINE SILICA PRESENT.</p>	
1750													<p>black &amp; bleached calcite</p> <p>comp. fol. dip in 10°</p>	<p>1744.8-1802.5' DENSELY WELDED VL-PH (w. 40%) FELSIC A.F.T. MED-DARK PURPLISH TO BROWNISH-GRAY NAW FLAME/ BUT LOT ALL ARE CHLORITIZED - NAW HAVE GLOBULAR/VESICULAR TEXTURE; LITHICS HAVE DIMINISHED TO ABOUT 5%</p>	
1760															
1770													<p>GRADED CALCITE</p> <p>LARGE FLAME DIP 45°</p> <p>LCOMP. FOL. DIP n 20°</p> <p>COMP. FOL. n 45°</p> <p>(PLASTIC FLOWAGE?)</p>	<p>• BELOW n 1768 FT. - variable dips on compaction foliation - post-compaction flowage?</p> <p>• lithic % drops to &lt; 1%</p> <p>• 1770 - one large framew. changes dip from 10-45°</p> <p>• BELOW n 1775 FT. fsp. sl. etched-appearing, partially sericitized &amp; chloritized.</p>	
1780													<p>COMP. FOL. n 35°</p>	<p>• @ 1786: 5-7% QTZ. PHENS., 30% TL. PHENS.</p>	
1790													<p>COMPACTON FOL. DIP n 25°</p> <p>SLIPPERY FRACTURES DOMINANTLY VERY HIGH ANGLE</p>	<p>* 1786.5-1787.7: COOLING BREAK - GOES FROM DENSELY TO MODERATELY WELDED.</p> <p>* 1789.5-1797.5: RK IS HIGHLY FRACTURED, VEINED W/ CHL. CAL. SER. IN THAT ORDER</p> <p>90-97% TL. PHENS</p> <p>• @ 1794: 5-7% QTZ. PHENS.; AVG. SIZE (EUM) w. 1.5 MM. UP TO 3 MM.</p>	
1800														<p>COMP. FOLN. FLD. TENURE OUT</p>	

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM

LOGGED BY J.B. HULEN & T.N. GARDNER

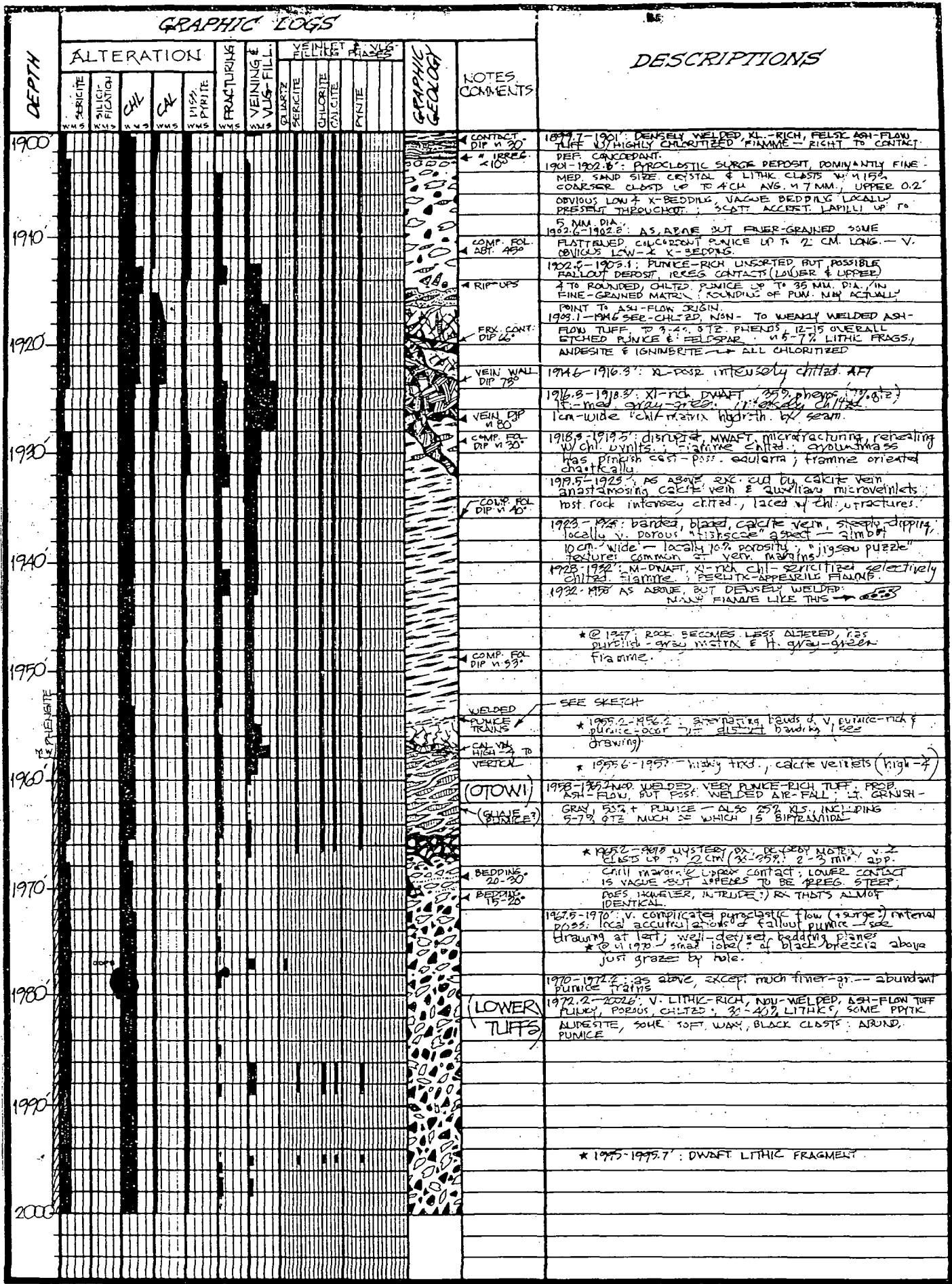
Aug. 19, 1988  
 20,

DEPTH	GRAPHIC LOGS											NOTES COMMENTS	DESCRIPTIONS		
	ALTERATION					FRACTURING	VEINING & VUG-FILL	YEINLET FELTUS	GLAUCOPHANE	CALCITE	PYRITE				
	HYDRATE	SILICIFICATION	CHL	CHL	DISS. PYRITE										
1800														COMP. FOL. DIP W 10°	PWAFT, AS ABOVE. 7-10% PTZ. PHENOS. 25-40% TL. PHENOS. (MAX. W 2 MM.)
														NOTE	* 1802.5-1804.5: CAVED RUBBLE EXTENSIVELY GROOVED GROUND & SMOOTHED BY THE BIT!
														HYDR. EX.	1804.5-1809: MOD. WELDED, XL-RICH FELSIC ASH-FLOW TUFF SIMILAR TO ABOVE; TL. PHENOS 25-30%, PTZ. 2-3%? ETCHED FSPs; PHENOS. ANG. W 1.0 MM. DIAMETER.
1810															* 1807.5-1808: HYDROTH. BRECCIA. CHL-CAL-SER-SER BY VEINLETS
															* 1813.6-1823: ROCK IS BLEACHED, SPREADING MORE HEAVILY CHLORITIZED & SERICITIZED. FSPs: ETCHED, SERICITIZED - also
															ONLY W 20% PHENOS (3-4% PTZ) - smaller avg. dia. than above & below (w 1-1.5 mm)
1820															
														COMP. FOL. DIP W 20°	1823-1892: DENSELY WELDED XL-RICH (40% AFT) AS ABOVE; ALTH. DECREASES, AS DOES FRACTURING & VEINING. CLEAR CORRELATION OF INTENSITY OF WELDING W/ INTENSITY OF ALTERATION.
															* 1826-1899: ROCK IS BLEACHED - obvious inverse relationship to high- $\gamma$ TRX.
1830															1892-1896: V. COMPLEX ZONE OF ALTERNATING MOD-WELDED, NON-WELDED & DENSELY WELDED ASH-FLOW TUFF. MOTTLED PURPLISH- & GRAY-GREEN - INCREASE IN ALTERATION
														COMP. FOL. DIP W 30°	* 1897.1-1897.4: ZONE OF HYDROTH. EX. cemented w/ CHL, CAL. & SERICITE.
1840															(V. LARGE - up to 25 mm. max. dia.)
															* 1845.2: 0.5-1 cm band of CHLITZ. PUMICE (a concentric rain - trans.)
														COMP. FOL. DIP W 50°	* 1846-1846.3: 11. gray-green, intrusive(?) pyroclastic band - see drawing at left.
														GRAY - GRT. SURGE (???) DIP 95°	* 1847.5: 1 cm-wide gray-green band, pass. 2 surge deposit (to check out!); IRREG BLEACHING OF WALL ROCKS OUT TO A DISTANCE OF ABOUT 2 CM.
1850															
															1896-1897.7: MOD. WELDED, XL-RICH, FELSIC ASH-FLOW TUFF. MED. PURPLISH-GRAY W/ SL. GREENISH- 7% PURPLISH-GRA. MED. LIGHTER FIAMME, 35% PHENOS TOTAL - 4.5% QUARTZ
1860															
														HYDROTH. EX.	* 1866-1867: HYD. EX. HEATED W/ CHLOR. & CALCITE
1870															* 1869-1880: APPEARANCE OF CHL-RICH MOTTLED, PLASTIC. LBY PERFORMED CLASTS POSSIBLE LOCAL PERLITIC TEXTURE. SOME ARE DEFINITE FIAMME.
															(ROCK IS) V. CHLORITIC - MOSTLY IN FIAMME & GLASSY, PERLITE CLASTS
														COMP. FOL. DIP W 45°	* 1879 - brick red chl, hem. on frac. surface.
1880															* 1881 - 0.2' zone of 65% + crystals
															* 1884-1885: + 5% of the chloritized matrix(?)
1890															
															* 1896: 8 cm rounded pyritic ankerite clast w/ cal. in. cut off at clast margins.
1900															* 1897.5 FT. HYDRAULIC FRX; MINOR HYD. EX.

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM

LOGGED BY J. HULEN & J. GARDNER  
 AUG 21, 1968  
 22

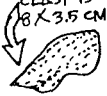
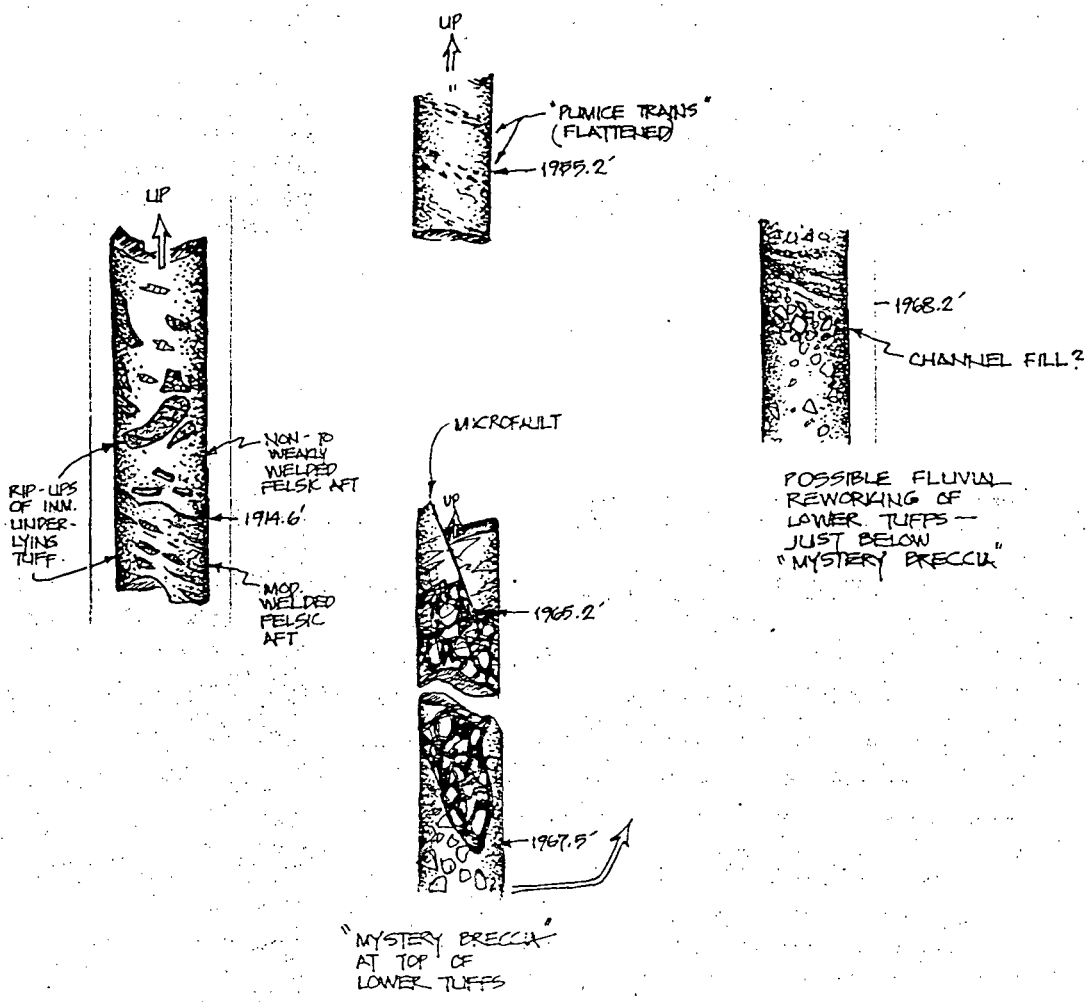




DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM

LOGGED BY J. B. HULLEN & J. N. GARDNER  
 AUG. 22, 1988

1902.5'  
 (IN SURGE)  
 LS. ANOE.  
 BOID CLAST  
 OF SAME  
 MATERIAL  
 AS MATRIX,  
 BUT  
 SLIGHTLY  
 LIGHTER  
 COLOR.  
 CLAST IS  
 18 X 3.5 CM

SKETCHES OF UNUSUAL FEATURES IN THE OTOWI MEMBER OF THE BANDELIER TUFF & IN THE LOWER TUFFS

GRAPHIC LOGS

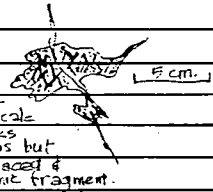
DEPTH PNEUMATE	ALTERATION										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS						
	SERICITE		ILLITE		CAL		DISS PYRITE		FRACTURING					VEINING & VUG-FILL	QUARTZ	EPIDOTE	CHLORITE	ANATASE	PYRITE
	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS									
2080																		<p>* LINKS UP TO 10X5 CM → DOM. PPHK, INTN.-COMP VOLCANIC ROCKS</p> <p>2002.6 - 2009.5': WELDED SURGES(?) : V. WELL-BEDDED, ALTERNATING PUMICE POOR &amp; PUMICE-RICH PLAINS (1MM-10MM THICK, PUMICE IS HIGHLY FLATTENED, CHLTD. MOD. WELDED FELSIC ASH-FLOW TUFF, lt. slightly greenish-gray w/ med. ash-grains on flame) flame of e. grad. small (avg 3-4 mm in length) unit has bedded aspect due to local concordations as flattened pumice swarms, overall in 7-10% pumice, 5-7% xls(?) - vague, 1-2% lithic</p> <p>* QUARTZ PHENOC. PROB. &lt; 2%, &lt; 1.5MM.</p> <p>(LOWER TUFFS)</p> <p>* BEDDED ASPECT LESS APPARENT BELOW 215', LITHICS SLIGHTLY MORE ABUNDANT 217' (3-4%)</p> <p>(ROCK IS PUNKY, NOTABLY UNFRACTURED &amp; UNVEINED)</p>	
2070																		<p>DIP 20°</p> <p>DIP 24°</p> <p>DIP 20°</p> <p>NON-TO</p> <p>2090.5 - 2094' WEAKLY WELDED, LITHIC-BEARING (w 2-3%) FELSIC ASH-FLOW TUFF: LT. GREENISH GRN, PUNKY POROUS; CLAST (LITHIC) UP TO 7 CM DIA., AND V. 1.5 CM DIA. MANY CLASTS ARE ANDESITE &amp; PPHK ANDESITE, OTHERS ARE SS, SLTST.</p>	
2060																		<p>DIP 33°</p> <p>2041.4 - 2042.8 FT. XL-RICH, f-gr., non-weakly welded pumice-poor, quite well-bedded tuff, but prob. ash-flow.</p> <p>2042.8 - 2045.5 FT.: V. XL-RICH (76%) SURGE(?); FAIRLY BEDDED, XL AUG. IN 1-1.5MM., LT. GRN-GED.</p> <p>2045.5 - 2046.6: OPTIC DACTILE, LT.-MED. &amp; PURPLISH-GRN PROB. A LARGE CLAST</p> <p>2046.6 - 2047.9: BRECCIA (PYROCLASTIC FLOW??); CLASTS OF 2-4CM. SWISSE, DACTILE, DWAST IN CALCITIC, GR. PHA. - BEAT IN MATRIX</p> <p>2047.9 - 2048.8: DENSE, MED. GRN SURGE(?) FAINT BEDDING</p> <p>2048.8 - 2049.5: BK SAME AS 2046.6 - 2047.9</p> <p>2049.5 - 2050.5: WEAKLY WELDED, V. LITHIC-RICH, FELSIC ash-flow tuff, punky, lt. greenish-gray, 30% lithics, aug. 1.5cm - 1.5 to 1.5cm, &amp; to subrounded, mostly intermediate volcanic some felsic AFT, rare chlorite; some pumice (pratic) up to 7-10 cm. in diameter; some black shale clast</p> <p>(LOWER TUFFS)</p>	
2050																		<p>FRX W/SLX 92' VP.</p> <p>2047.5 - 2047.9: BRECCIA (PYROCLASTIC FLOW??); CLASTS OF 2-4CM. SWISSE, DACTILE, DWAST IN CALCITIC, GR. PHA. - BEAT IN MATRIX</p> <p>2047.9 - 2048.8: DENSE, MED. GRN SURGE(?) FAINT BEDDING</p> <p>2048.8 - 2049.5: BK SAME AS 2046.6 - 2047.9</p> <p>2049.5 - 2050.5: WEAKLY WELDED, V. LITHIC-RICH, FELSIC ash-flow tuff, punky, lt. greenish-gray, 30% lithics, aug. 1.5cm - 1.5 to 1.5cm, &amp; to subrounded, mostly intermediate volcanic some felsic AFT, rare chlorite; some pumice (pratic) up to 7-10 cm. in diameter; some black shale clast</p> <p>(LOWER TUFFS)</p>	
2040																		<p>FRX DIP 70°</p> <p>@ 2075: 2 cm clast of water-reworked tuff w/ abund. frosted bipyramidal gr.</p> <p>* 215, 216, 217: fracture w/ 3-5mm surge, chlted, hematized nearby chloritic pumice w/ hair. fims.</p>	
2030																		<p>* LITHE % DECREASES TO ~ 15%</p> <p>NOTE: PUMICES UP TO 4 CM. IN LENGTH</p>	
2020																		<p>2092 - up to non welded lithic xtal rich (90% pumice/matrix selectively chloritized; rock markings, etching after felds.</p> <p>- 10-20% lithics dom. P.C. and w/minor welded ign. ss(?); ~ 2100' some "mafic lithics" appear plastically deformed; lithics up to ~ 5cm</p> <p>- xtal content to 2100 ~ 2090</p>	

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.

HULEN &  
 LOGGED BY GARDNER  
 3 Sept 88





GRAPHIC LOGS										NOTES COMMENTS	DESCRIPTIONS										
DEPTH & PHENOGITE	ALTERATION					FRACTURING	VEINING & VLS-FILL.	VEINLET & VLS				GRAPHIC GEOLOGY									
	SP	SILICIFICATION	CHL	CR	DISS PYRITE			QUARTZ	SERICITE	CHLORITE	CALCITE		PYRITE								
2200																					
2310																					<ul style="list-style-type: none"> <li>2206 - 2311: enrichment in light grey-green pyroclite clasts as above</li> <li>2307.5 - 2309: IRRREG. SHEAR ZONE PARTLY OCC. BY CAL. VNL. w 70° DIP.</li> <li>Below 2311: welding increases to mod. intensity lithics decrease to w 15% (to 2325 FT)</li> </ul>
2320																					<p>COMPACTION FOLIATION DIP w 10-15° (VAGUE)</p>
2330																					<ul style="list-style-type: none"> <li>BELOW 2325: LITHICS DECREASE TO w 10%</li> </ul>
2340																					<ul style="list-style-type: none"> <li>2328.5 - 2331: zone of mod. int. fracturing, veining - frx hackly, irreg. but most dip 60-70°, most are partially coated w fishscale calcite (3-5); brownish-grey microclin. silica local euhedral qtz ~ 1mm. long; tr. pyrite only on fractures; possible trace ep.</li> </ul>
2350																					<ul style="list-style-type: none"> <li>234.5 - 234.8: shear zones - lower one w 10 mm. 2342.5 - 2344: wide - dipping w 65-70°; upper - 1-2 mm. may be some hydrothermal breccia associated with both of these.</li> </ul>
2360																					<p>PROBLE DRILL-IN-DUCED</p>
2370																					<ul style="list-style-type: none"> <li>BELOW 2348: frx becomes much coarser, prob. more phenocryst rich; frx some become much more prominent, size of framme up to 5x1 cm; lithic content 7-10%, and 3-10 mm, locally up to 6 cm.</li> </ul>
2380																					<p>RUDDLE</p>
2390																					<ul style="list-style-type: none"> <li>n 2370.8 10225 mass of ch. phenocryst &amp; fishscale calcite, looks like fiammus but may be replaced &amp; infilled lithic fragment.</li> </ul> 
2400																					<p>DENSELY WELDED XL &amp; LITHIC-RICH FELSK ASH-FLOW RUFF. H. greenish-grey, pinky even though densely welded, 5-7° lithics up to 2.5 cm (avg. n 1 mm) in dia. + these are mostly pyritic, inter-mediate composition volcanic rx, minor sp. qtz, microcline (3); framme up to 5x1 cm, avg n 5x1-2 mm - these are med. grey-green, much darker than matrix; some of the vol. lithics contain hematite after original mafic minerals</p>
																					<p>COMP. FOL DIP w 10°</p>

DRILL HOLE YC-2B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.



J. B. HULEN &  
LOGGED BY J. N. GARDNER

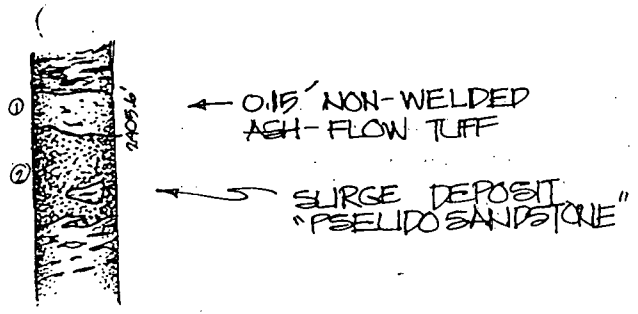
8 SEPT, 8-9 DEC. '88

GRAPHIC LOGS										NOTES COMMENTS	DESCRIPTIONS					
DEPTH METERS	ALTERATION					FRACTURING	VEINING & VUG-FILL	VEINLET FILLING				GRAPHIC GEOLOGY				
	PHENIGITE	CHLORITE PILONIAI	CHL	CA	DISS PYRITE			QUARTZ	SEPCITE	CHLORITE	PHENIGITE		HEM			
2400																DENSELY WELDED, PULVIC ASH-FLOW TUFF, AS ABOVE
2410																<p>SURGE</p> <p>* 2405.5-2405.6: XL-DEFICIENT &amp; LITHIC-DEFICIENT (LST); &lt; 7MM) LAMEE; SHARP UPPER CONTACT.</p> <p>* 2405.6-2405.8: SURGE? Texturally a med. grnd. sandstone w/ qtz. In lithic, well-sorted, lt. gray (covered or covered?) app.</p> <p>① 0.15' zone of non-welded tuff 3-4' fairly planar upper contact (&amp; lower contact) above sandstone-like surge deposit.</p>
2420																<p>← COMP. FOL. DIP 4-20°</p> <p>(LOWER TUFF)</p>
2430																
2440																<p>2434-2434.1: POORLY- TO MOD. WELDED ASH-FLOW TUFF, OTHER- WISE SIMILAR TO ABOVE;</p> <p>2434.1-2434.15: IRREG. BAND OF ALTERED FINE ASH W/IN 2-3% 1 mm XL's, MOSTLY RTZ, SOME FELTSPR</p> <p>2434.15-2434.75: PROBABLE SURGE DEPOSIT, dense lt. brownish-gray; texturally a well-sorted, med. grained ss. with suspended clasts of various rock types, subround to angular, up to 2 cm dia. Clasts are predominantly andesite &amp; sandstone, similar to the matrix, lower 5 cm vaguely plane-bedded, generally coarser (2 grains)</p> <p>2434.75-2435: med. cts. grm. sl. hematitic ss. contorted bedding, upper SCOUR channel filled with darker clastic sandstone</p>
2450																<p>2435-2435.3: interbedded lithic-rich, lt. gray-green tuff &amp; med. gr. tuffaceous sandstone sl. reddish</p> <p>2435.3-2435.8: thin bedded, way to convolute to plane-bedded, hematitic ss. soft-sed. deformation</p> <p>2435.8-2436.8: highly contorted poorly-sorted, fine-med. gr. hematitic (slightly) lt. reddish sandstone; scatt. stub. hem. veinlets, some soft sed. deform.</p> <p>(CARBONATE)</p> <p>2436.8-2441: complexly deformed (fractured/healed &amp; folded) sediment deformed fine to coarse grained sandstone 2441-2444: red, contorted, fine gr. sandstone</p> <p>(DEBRIS FLOW)</p> <p>2441-2443: red med. gr. sandstone breccia invading med. gr. sandstone. The breccia contains clasts of porphyritic andesite up to 2 cm dia. (angular) &amp; PLAIN in left.</p> <p>(TUFF)</p> <p>2443-2452: Med. gr. sl. hematitic, highly soft-sed. contorted sandstone, dips range from near-horizontal to vertical. Same as 2441-2443</p> <p>* 2449-2450.5: coarse grit/breccia w/hem. matrix intrudes sandstone (concordant - may not be intrusion)</p>
2460																<p>(DEBRIS FLOW)</p> <p>(COCHITI FM. EQUINAL?)</p> <p>2447-2452.8: TUFF(?) lt. gray-green w/ 7% clasts - white volc. rx? fine-xln. limestone up to 15 mm. - gradational lower contact; clasts up to 4 cm, avg. 1-2 cm dia.</p> <p>2452.8-2453.6: v. fxl. lt. med.-gray limestone; silty (not a class)</p> <p>(SANTA FE)</p> <p>2453.6-2454.1: same as 2452-2452.8</p> <p>2454.1-2455.2: limestone, same as 2452.8-2453.6, but grading from vel. pulv. to complexly intertinged with tuff as above</p> <p>SILICA-PHENIGITE VEINLETS</p> <p>2455.2-2457.2: debris-flow? v. calcareous matrix breccia with clasts of andesite up to 15 cm, clasts of limestone as above up to 4 cm.</p> <p>2457.2-2457.8: DEBRIS-FLOW DEPOSIT, subdiv. to round clasts of andesite &amp; pyritic andesite, rare lith. in a very calcareous matrix - silty as well.</p> <p>2457.8-2463: TURFACEOUS SLTSPHNE, lt. gray-green, ultra-fine-grained, tiny shank visible; looking at upper contact.</p> <p>(SANTA FE)</p> <p>2460.8-2469.8 DEBRIS-FLOW DEPOSIT, SAME AS ABOVE; ANDESITE CLASTS UP TO AT LST. 15 CM. IN DIA.</p>
2470																
2480																
2490																<p>2469.8-2619: LITHIC-AROSE, LT. GRAY TO BUFP, REFER TO FOLLOWING PAGE FOR DESCRIPTION!</p>
2500																<p>2495-2495.8: CAL VNLTS BANDED UP TO 1 CM. WIDE, 75° DIP w/ 3 CM. OFFSET OF OLDER PHENIGITE-SILICA "SOAK" VEINLETS dipping 10-15°.</p> <p>← CALCITE VEINS</p>

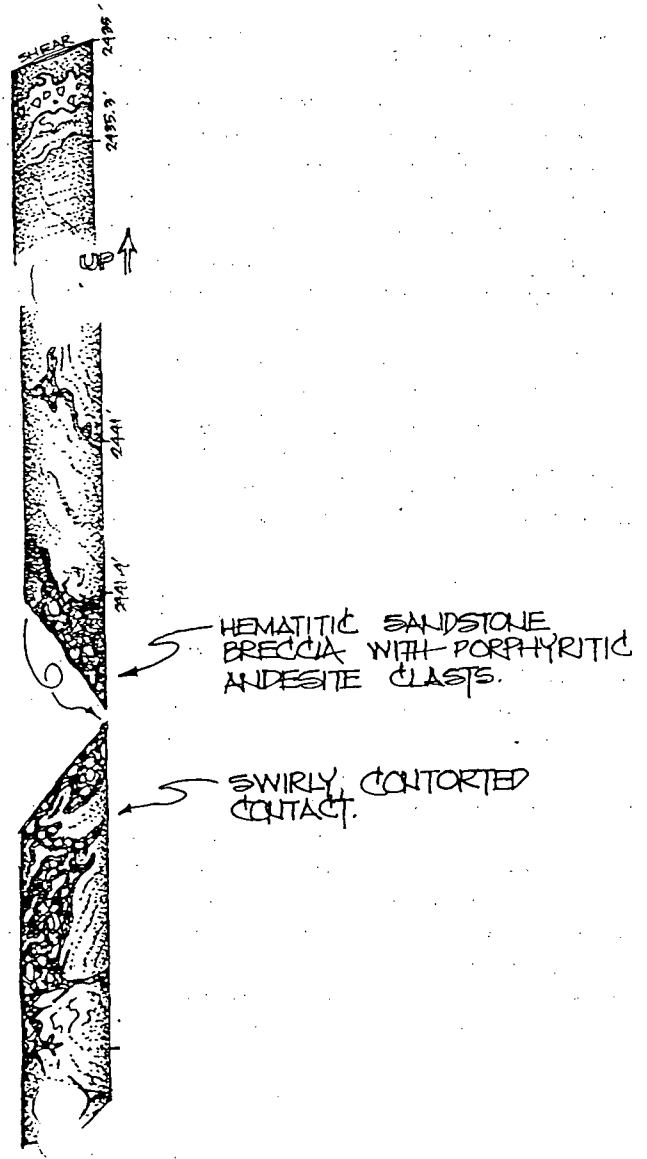
DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS  
 VALLES CALDERA, N.M.



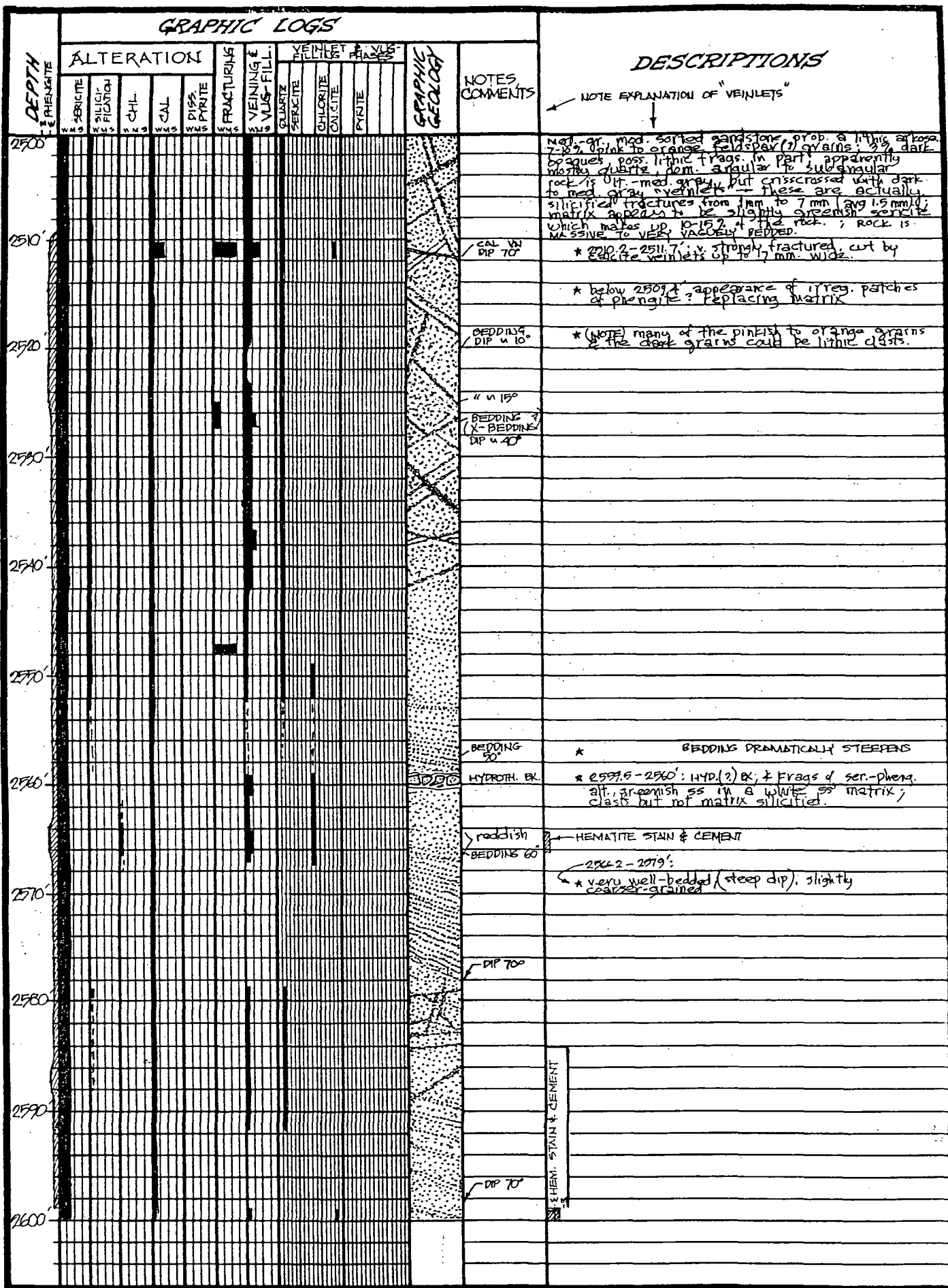
J.B. HULEN  
 LOGGED BY J.N. GARDNER  
 SEPT. 8, 1988



SKETCHES OF UNUSUAL  
 FEATURES IN THE LOWER  
 TUFFS & UNDERLYING  
 SANTA FE GROUP? SAND-  
 STONE







DRILL HOLE VC-28 (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.

LOGGED BY J. B. HULEN  
SEPT. 6, 1988

DEPTH	GRAPHIC LOGS											GRAPHIC GEOLOGY	NOTES COMMENTS	HEM. STAIN/CEMENT RELATIVE INTENS. SITY.	DESCRIPTIONS	
	ALTERATION					FRACTURING	VEINING & VUG-FILL	VEINLET FILLING & PLACES			GRAPHIC GEOLOGY					
	SERICITE WMS	SILICIFICATION WMS	CHL WMS	OPAL WMS	PIPS WMS			QUARTZ WMS	CHLORITE WMS	CALCITE WMS						PYRITE WMS
2600																TO 2629': LITHIC ARKOSE, AS ABOVE. * 2602.6' - Mod. abund. stkwk qtz. veinlets" (soak of ss.) up to 5 mm. wide. * @ 2605: 7-9 cm band of conformed ss. discordant possible clastic diking - cuts qtz. veinlets.
2610																* 2613-2615: Highly disrupted interval w/ bedding chaotic orientation; randomly-oriented qtz. "veinlets" as above. * ROCK IS BECOMING MORE MAROON w/DEPTH, BUT SEE NO MAJOR CONTACTS YET.
2620																* CONTACT @ 2620' DIP * @ 2618.8': 30' CONTACT BETWEEN NON- TO WEAKLY HEM. SS & STEADY HEM. SS.
2630																(YESO FM) 2629-2631: SILTY SANDSTONE, fine-grained, lt. purplish-gray to reddish-gray, generally very vague bedding * 2627-2628.4: prominent wavy lamination, disturbed, possibly bioturbated.
2640																2631-2637: silty, fine-gr. hematitic sandstone, mottled appearance, possibly bioturbated locally, very hematitic 2637-2640.9: interval grading downward from muddy siltstone through fine & med. gr. silt. sandstone to coarse, x-bedded, gravelly sandstone (UPWARD-FINING SEQUENCE) 2640.9-2641: variably calcareous, silty to muddy sandstone w/ thin muddy siltstone to clay mudstone laminae; hematitic; well cross-bedded; lower 0.2 ft. prominently bioturbated.
2650																(X-BEDDED) BEDDING w/ 30° DIP 2641-2652.8: calcareous, mottled, hematitic silty sandstone, massive; 1-2 mm. calcite concretions in upper 0.8 ft. 2652.8-2655.1 ft.: as above, but very calcareous less hematitic; v. well bedded to 2653.2', mottled qtz. possibly bioturbated below.
2660																2655.1-2656.9 ft.: mottled, poss. bioturbated, definitely disrupted, interbedded hematitic mudstone & silty sandstone 2656.9-2660: same as 2640.9-2641 (X-BEDDED)
2670																2660-2699: massive to vaguely bedded, hematitic, variably calcareous sandstone, med. well-sorted.
2680																
2690																2689.9-2692.2: mottled, probably bioturbated calcareous hem. ss. interbedded w/ lt. gray limestone 2692.2-2700: massive hematitic sandstone, same as 2660-2699 (lower portion)
2700																

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA  
 NEW MEX.



LOGGED BY J. B. HULEN  
 SEPT. 6, 1980

DEPTH	GRAPHIC LOGS ** "CAL" COLUMN THIS PAGE REFERS TO DIAGENETIC CARBONATE										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS
	ALTERATION				FRACTURING	VEINING & VUG-FILL.	GLAUCZ PEROLITE	VEINLET FILLING	CHLORITE	PYRITE			
	SERICITE	MICA FILICON	CL	DISS. PYRITE									
2700												2702	MASSIVE SANDSTONE, AS ABOVE.
												2709	2702-2709: x-bedded, interbedded hem. silty ss & hem. mudstone/shale 2709-2724: Mostly massive, hematitic, silty sandstone, as above, variably calcareous.
2710													* 2712-2719.2: diss. irreg. blath-like to omeoid calcite clots dg. v. 5-7 mm long some of these possibly filled burrows.
2720													
2730													2791-2792.8: silty mudstone, variegated purple and blue-red, flame structure & rip-ups at base 2792.8-2793.9: silty limestone weakly hematitic, wavy laminated bedding 2793.9-2794.8: calcareous hematitic, silty mudstone & muddy siltstone; local disturbance 2794.8-2797.8 Ft.; upward-tining ss to siltstone sequence 2797.8-2798: laminated purple mudstone & H. gray limestone 2798-2799.7: H. gray limestone 2799.7-2799.8: laminated purple mudstone and H. gray siltstone & sandstone; wavy lamination, bioturbated (?), variably calcareous. 2799.8-2799.9: SANDSTONE, fine-gr. massive to plate-bedded, locally x-bedded; poss. some soft-sed. deformation; hematitic 2799.9-2794.1: interbedded red ss, as above, & H. gray silty limestone, nodular appearing, wavy lamination.
2740													2754-2758.6: same as 2794.5-2799.1 Ft.
2750													2858.6-2860.2: v. hematitic, interbedded silty mudstone & muddy siltstone 2860.2-2861.8: hem, muddy to silty fine ss, bioturbated, w/ abnd. burrows up to 2x 0.7 cm, filled w/ xln. calcite 2861.8-2865: finely laminated, red muddy siltstone, burrows as above, upper 0.9 ft. 2865-2866: interbedded hem silt/ss & H. gray to buff silty limestone 2866-2876: fine-gr. s. hematitic silty ss, vaguely bedded
2760													2776-2783.4: med.-grained, s. hem. sandstone nearly massive 2783.8-2785.5: fine-gr. well-bedded sandstone
2770													2785.5-2786.0: same as 2776-2783.8 2786.0-2788: calcareous & hem. ss, bioturbated med.-grained 2788-2789.5: vaguely bedded hem. fine-gr. ss 2789.5-2791.0: buff, med-gr. calcareous sandstone 2791.0-2792: bioturbated, interbedded calcareous sandstone and red hematitic mudstone (laminated) 2792-2793.5: same as 2788-2789.5 2793.5-2795: calcareous & hem. fine gr. ss 2795-2803: app. massive, fine-gr., hem. ss. * 2796.4-2798.2: mottled - origin unknown
2780													
2790													
2800													

DRILL HOLE VC-2B (FIELD LOG)  
LOCATION VALLES CALDERA, NEW MEXICO



LOGGED BY J.B. HULEN  
SEPT. 7, 1988

GRAPHIC LOGS												** "CAL" COLUMN THIS PAGE REFERS TO PRIMARY & DIAGENETIC CARBONATE.		NOTES COMMENTS	DESCRIPTIONS
DEPTH	ALTERATION					FRACTURING	VEINING & VUG-FILL	GIBBZ	REPICIT	GILGRIE	CAL	GRAPHIC GEOLOGY	HEM STRAIN/CEMENT (REL. INTENSITY)		
	PERICITE	SILICIFICATION	CHL	CAL	PISS PYRITE										
2800'														2801-2809.8: hem. v.f. - fine gr. ss.	
2810'														2809.8-2820: fine-grained sandstone, variably calcareous, massive to vaguely bedded, locally disturbed, calcite-filled burrows and common, local flame structures & rip-ups; gray calcite microveinlets, upper 0.9 is bright red; veinlets; local beds of lt. gray to buff limestone, as noted on graphic log.	
2820'														2820-2820.7: lt. gray to buff limestone, lenticular bedding; 2.9" thin hem. mudstone lamina; 2820.7-2822.9: interbedded hem. ss, as above, & limestone as immediately above; 2822.9-2825.1: upward-fining ss to siltstone.	
2830'														2825.1-2826.8: limestone lt. gray as above; locally cracked, reheated w/calc.	
2840'														2826.8-2842.1: same as 2803.8-2820.7 except only sparse local filled burrows.	
2850'														2842.1-2844.8: Limestone, as above, except contorted, mixed w/ about 7% hematitic sandstone & siltstone.	
2860'														2844.8-2857.5: SANDSTONE, same as 2820-2842.4	
2870'														2857.5-2858.5: LIMESTONE, same as 2842.1-2844.8.	
2880'														2858.5-2859.5: BED SANDSTONE AS ABOVE, variably calcareous, some deformation; coarse grained, local upward-fining character; local amoeboid "patches" of calcareous cement.	
2890'														2859.5-2865.5: calcareous, hematitic sandstone, local limy concretions, filled burrows (calcite); mottled appearance; local wavy bedding.	
2900'															

DRILL HOLE VC-28 (FIELD LOG)  
 LOCATION VALLES CALDERA, NEW MEXICO

LOGGED BY J. B. HULEN  
 SEPT. 7, 1968

**GRAPHIC LOGS** \*\*CAL COLUMN THIS PAGE REFERS TO PRIMARY & DIA-GENETIC CARBONATE.

DEPTH	ALTERATION										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS
	SERICITE		SILICEOUS FILLING		CHL		CAL		PYRITE				
	WMS	MS	WMS	MS	WMS	MS	WMS	MS	WMS	MS			
2900'												<p>2900.5-2905: scattered calcite stringers, clots, concordant veinlets; clots are likely filled burrows</p>	
2910'											<p>2907.5-2910.5: INTERBEDDED SILTY WHITE LIMESTONE AND RED, HEMATITIC SILTY CALCAREOUS SANDSTONE; ls's appear recrystallized, but still retaining</p>		
2920'											<p>2910.5-2912: contorted, fractured, rexted. limestone bk (primary or diagenetic brecciation)</p>		
2930'											<p>ANH</p> <p>* SCATTERED ANHYD. NODULES TEXTURALLY SIMILAR TO CALCITES.</p>		
2940'											<p>2936.5-2937.5: white, prop. rexted. limestone sparsely laminated with hem. mudstone; wavy, contorted lamination.</p> <p>* minor interlaminated</p> <p>* some graded bedding</p>		
2950'											<p>X-bedding</p> <p>BURROWS</p>		
2960'											<p>ANH</p> <p>ANH</p> <p>DIP 10° (X-BEDDING)</p> <p>BURROWS</p>		
2970'											<p>X-BEDDING</p> <p>DIP 10°</p> <p>ANH</p> <p>ANH</p> <p>2975.1-2976.1: zone of 1/2" to 3/4" anhyd. nodules &amp; stringers in 15-20% of the rock.</p>		
2980'											<p>20° DIP (CW)</p> <p>SANDSTONE, FINE-MED. GR. HEMATITIC, LOCALLY CALCAREOUS; Wavy to LENTICULAR BEDDED; SPARSE LOCAL ANHYD. NODULES 2-10 mm. L/ hori to vert. orientation - prob. filled burrows.</p>		
2990'											<p>ANH. BED</p>		
3000'													

DRILL HOLE VC-02 (FIELD LOG)  
 LOCATION SULPHUR SPRINGS  
VALLES CALDERA, N. MEXICO



LOGGED BY J.B. HULEN  
SEPT. 9, 1968

GRAPHIC LOGS \*\*CAL\* COLUMN THIS PAGE REFERS TO STRATA & FACIES TO CARBONATE.

DEPTH	ALTERATION					FRACTURING	VEINING & VUG-FILL.	VEINLET & VUG-FILLINGS				GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS	
	QUARTZITE (SUS)	SILICIFICATION (SUS)	CHL (WMS)	CP (WMS)	DISSEMINATED PYRITE (WMS)			QUARTZ SERICITE	CHLORITE CALCITE	ANHYDRITE PYRITE	GRAPHIC GEOLOGY				
3000															* 3009.4-3007: CRST. XLN, gen. v. m. massive ss
3010															* 3010.0 - curious open fractures app. caused by effect of cold drilling fluid on hot rock (thermal cracking) up to 1mm. wide PLUS ANHYDRITE
3020															* 3016-3018: XLN. CALCITE VEINLET, LOCALLY OPEN BEAUTIFUL VUGS AVG. 3 MM. DIA., SOME ANH. XLS. UP TO 13 MM. LONG. → VEINLET UP TO 10 MM. WIDE. CAL-ANH VEINLET. DIP N 90°
3030															ANH. BED.
3040															* 3039.2-3036.6 SANDSTONE, LT. MARGON TO LT. BRKY RED FINE-GR. APT. WELL-SORTED SANDSTONE PROB. A. SUBARKOSE; MASSIVE TO VAGUELY BEDDED * 3032-3032: STOCKWORK "SILICA SOAK" VEINLET UP TO 2 MM. WIDE (QUARTZ) * 3041-3045 MOD. ABUND. ANHYDRITE NODULES * 3049.5-3050.0: 8 STRINGERS, SOME 2' DEEP TO BE FILLED BURROWS, SOME ARE DIAGENETICALLY DISRUPTED STRATA UP TO 0.3 FT. THICK (SILICA SOAK, FTZ VEINLET) ANH.
3050															ANHYDRITE
3060															ANH. DRILLING INDUCED FRACTURES
3070															BEDDING PLANE SLIK DIP 25° ANH.
3080															ANHYDRITE BED * 3076.6-3077.9: MASSIVE white anhydrite, lower 0.15' subbrecciated * 3077.9-3052: same as 3039.2-3036.6
3090															ANH.
3100															* 3051-3090: distinctly-bedded (plane to low- $\gamma$ X) med.-poor fine-gr. ss; local mudstone microclasts * 3090-3105 SANDSTONE, fine-grained, weakly hemi-massive to plane to wavy-bedded. local calcite & anhydrite nodules, local bioturbation (FIPAL FLAT)

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 NEW MEXICO



LOGGED BY J. B. HULEN  
 D. F. WILSON  
 C. W. CRISWELL  
 SEPT. 10, '88



DEPTH	GRAPHIC LOGS										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS				
	ALTERATION					VEINING & VUG-FILL.	VEINLET FILLINGS			VEINLET PHASES							
	QUARTZ SERICITE	SILICIFICATION	CHL	CR	DISS. PYRITE		QUARTZ	SERICITE	CHLORITE					CALCITE			
3100																	
3110																	
3120																	
3130																	
3140																	
3150																	
3160																	
3170																	
3180																	
3190																	
3200																	

NOTE: "VEININGS & VUG-FILLING" RECORDED ON THIS PAGE IS PRINCIPALLY DIAGENETIC CARBONATE & SULFATE AS NODULES & BURROW-FILLINGS: MINOR QTZ & CALCITE VEINING PRESENT FOR 31 23 ABOVE

\* 3107-3111: calcined brick red mudstone microclasts appearance much like friam, up to 2X0.19 cm.

3115.5-3129.2: VF to F GR. ss, light reddish to pink color, wavy-bedded w/ sparse laminae of brick red argillaceous siltstone; upward-fining sequences up to 1.9' thick; sparse cement, local calcite nodules & stringers

3129.2-3152.8 ss, as above, ex. locally interrupted by limestone beds, zones of nodular calcite & anhydrite

\* 3199.5-3199.8: wavy, inter-laminated white fine-xln. calcite (40%) & lt. gray-green talose layer silicate.

\* 3195.7-3195.8: m.xln. kerol. calcite/limestone

\* 3136.0-3136.9: BRECCIA: FRAGS OF RED SS, AS ABOVE, EMBEDDED IN WHITE PORCELLANEOUS MATRIX MOST OF WHICH IS CALCITE, EX. FOR 2-3 cm bright white chert band at 3136.5' also bedding varies from wavy to plane to massive

3151-3152.8: complex, inter-laminated & internally brecciated limestone, w/ minor mudstone & anhydrite upper 0.15' varied-appearing microlaminated limestone and mudstn.

3152.8-3156.2: sandstone, as above

3156.2-3162.0: finely interbedded red ss & white limestone, as above

3162-3167.7: same as 3115.2-3129.2'

3167.7-3170.5: same as 3156.2-3162.0'

3170.6-3175.5: same as 3115.2-3129.2'

3175.5-3176.3: same as 3156.2-3162.0'

3176.3-3180.5: same as 3115.2-3129.2'

3180.5-3199.7: same as 3156.2-3162.0 FT. (complexly inter-laminated & interbedded white limestone & red, fine-gr. ss (hematitic))

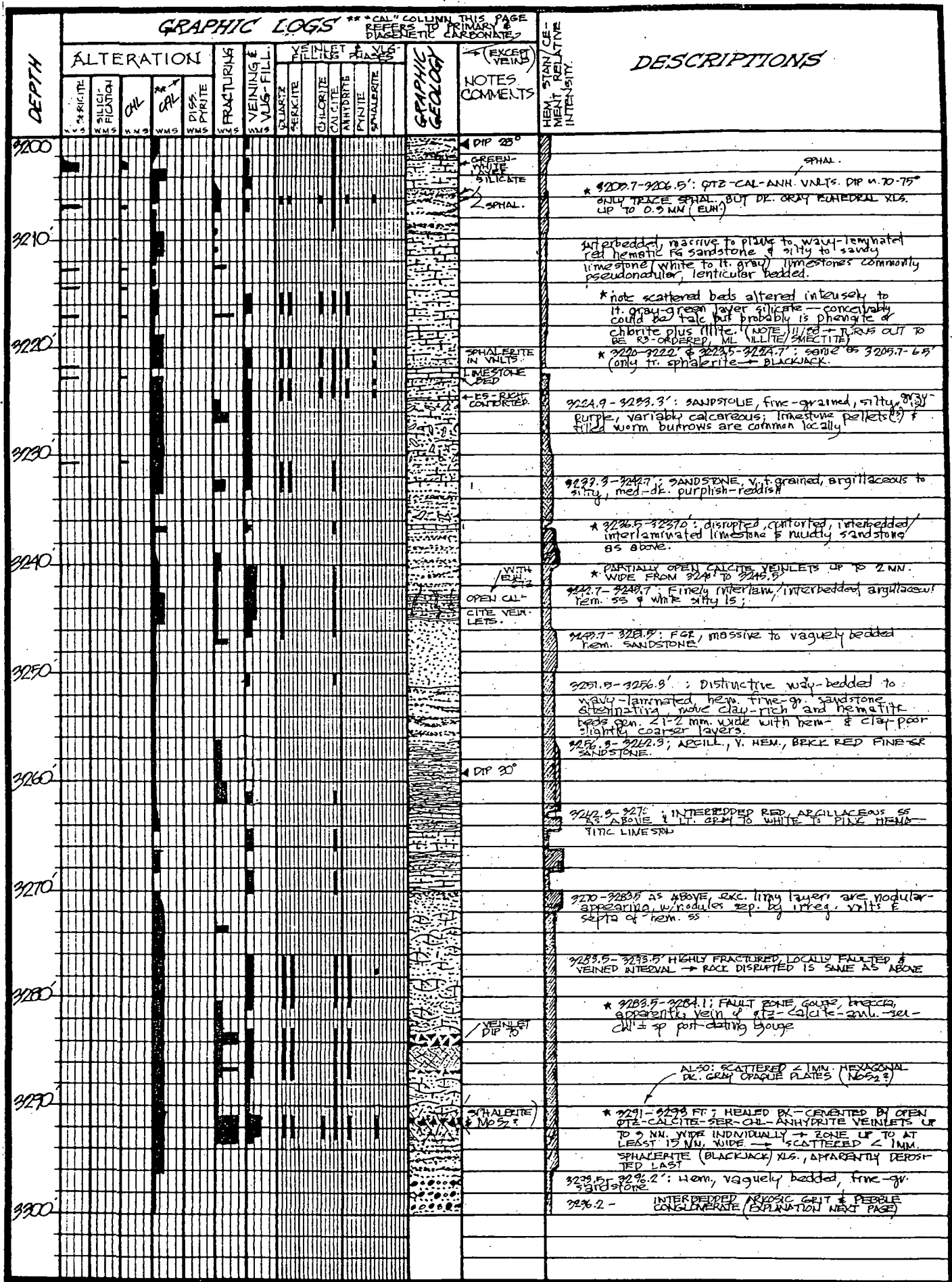
\* 3186.9: ls. granule(?) layer 2 cm. thick

\* 3194.2-3199.6: ROCK HAS BEEN CONVERTED TO WAVY-APPEARING LT. GRAY-GREEN LAYER SILICATE; POSSIBLY SERICITE OR TALC. TR. DISS. CHL. CLOTS < 1.5 MM. DIA. → NOTE CORRESPONDENCE WITH VEINING & FRACTURING.

DRILL HOLE VC-2B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.



LOGGED BY J.B. HULEN  
SEPT. 10, 1988



DRILL HOLE VC-28 (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.

LOGGED BY J.B. HULEN  
 SEPT. 11, 1988



DEPTH	GRAPHIC LOGS												GRAPHIC GEOLOGY	NOTES COMMENTS	STAIN & MELT RELATIVE INTENSITY	DESCRIPTIONS	
	ALTERATION					VEINING & VUG-FILL	VEINLET PHASES			HEMATITE							
	EPICRITE	SILICIFICATION	CHL	CR	DISS. PYRITE		QUARTZ	SERICITE	CHLORITE		CAICITE	PYRITE					
9300																DIP 10-20°	
9310																	9305.5-9308.2: ARKOSIC CONGLOMERATE; 2 TO RND. CLASTS UP TO 7 CM. IN DIA. BOTH PRECAMBRIAN GRANITE & GNEISS AS WELL AS DK. GRAY TO PURPLE-GRAY PORPHYRYTIC ANDESITE; Vague bedding @ u 15°
																	* 9315-9315.5: slickensided fracture
9320																	
9330																	* 9325.4-9328.4: Round andesite cobbles up to at least 10 cm in diameter. (also porphyritic andesite & possibly intermediate composition ash-flow tuff)
9340																	@ u 9338 → VOLCANIC CLASTS LARGELY DISAPPEAR, TO BE REPLACED BY 95% ± PG GRANITE, MINOR GNEISS; matrix is hematitic siltstone to sandstone. Clasts up to at least 10 cm. diameter
9350																	
9360																	9358.2-9362.7: SANDSTONE, med. gr. poorly-sorted, hematitic, massive to weakly bedded, sparse granite granules & fine pebbles
																	DIP 10°
9370																	9362.7-9370.9: as above except coarse-grained scattered pebble beds up to several cm thick
																	9370.9-9372.6: brick red, med. silty mudstone/shale
9380																	9372.6-9385.1: ss, coarse-gr. poorly-sorted, X-bedded abundant red mudstone rip-ups up to 15 cm. long.
																	9385.1-9390.2: FINE-MED. GR. MED. SS, massive to finely X-bedded (toward base), sparsely bedded
9390																	9390.2-9396.9: SILTY MUDSTONE, brick red, v. hematitic highly fractured w/ slick on many; poss. some thermal fracturing as well.
9400																	9396.9-9400.5: sandstone, described next page.

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA

LOGGED BY J. HULEN  
 J. GARDNER  
 SEPT. 12, 1988

GRAPHIC LOGS

CAL' COLUMN THIS PAGE REFERS TO PRIMARY & PLAGE-NEUTIC CARBONATE (E.G. VEIN)

DEPTH	ALTERATION										GRAPHIC GEOLOGY	NOTES COMMENTS	HEMATITE STAIN & INTENSITY	DESCRIPTIONS			
	SERICITE		MILCH-IFICATION		CAL		DISS PYRITE		FRACTURING	VEINING & VUG-FILL					GLAUCOSE SERICITE	CHLORITE CALCITE	PYRITE
	WMS	AMS	WMS	AMS	WMS	AMS	WMS	AMS									
3400															<p>sandstone med-gr. f. med. &amp; v. light, calc. greenish massive, planar, &amp; thin X-bedded; bleached (reduced) patches v. light, slightly greenish-gray up to 10 cm. dia. bulbous to amoeboid calcite concretions (?) with some clay (?) up to 10 cm. dia. also bulbous, w/ brecciated appearance</p> <p>* @ 3405 ft. - argillaceous, coarse sandy, purky clasts w/ 2x 1 cm. smile-like vug w/ anhydrite plates up to 10x5x1 mm.</p>		
3410																	
3420															<p>3420.8-3428.7: ss, med-gr. - fining upward, abundant sand-size shale clasts (hematitic) prob. argillaceous &amp; poorly-sorted; vague to massive bedding.</p> <p>DIP 10-15°</p>		
3430															<p>(YESO FM)</p> <p>3428.7-3433.5: As above, but abundant pebble-size shale/mudstone rip-up clasts up to 15 mm. highly</p>		
3440															<p>CLASTIC DIKE</p> <p>(NO FM)</p> <p>3433.5-3435.5: ss, same as 3420.8-3428.7 except highly bleached ft. gray-green.</p> <p>* 3432.7-3434.4: CLASTIC DIKE hematitic where not bleached; sandy to silty mudstone in host of med. gr. ss. up to 1 cm. wide - see drawing at left</p> <p>3435.5-3448.5: hematitic silty mudstone, highly fractured, locally common calcareous concretions, bulbous to amoeboid, up to at least 20 cm. dia.</p>		
3450															<p>3448.5-3454.6: As above except sandy - sand increases &amp; coarsens w/ depth. lower 0.6' rich in pebbles up to 10 mm. dia</p> <p>DIP 17°</p>		
3460															<p>3454.6-3467.5: Massive, calcareous, hematitic silt-stone, mottled, interformationally brecciated appearance: *MARI; locally bleached/reduced to v. lt. slightly greenish-gray. both in rounded, amoeboid</p>		
3470															<p>3467.5-3472.2: As above, except less calcareous, more mud-size fraction; lower 2 ft sparse bleached/reduced spots up to 15 mm - highly rounded.</p>		
3480															<p>3472.2-3482.0: Calcareous mudstone to siltstone, similar to 3454.6-3467.5, except less calcareous, locally more silty, also more fractured &amp; widely "spotted" - bleached, reduced areas up to 2 cm. - some of these have slightly darker but soft centers - some spots have double halos.</p>		
3490															<p>3482-3487.6: massive, poorly-sorted, poss. argillaceous fine-gr. sandstone</p> <p>* 3484.6-3485.2: bleached zone in ss. also scattered, bleached clots up to 3cm. wide for 0.4 ft above this larger clot</p> <p>3487.6-3495.5: med-cr. gr. prominently X-bedded sandstone; lower 0.7 ft bleached, as is upper 2-10 mm of underlying mudstone; heavy mineral concentration @ 3494.</p>		
3500															<p>3495.5-3501: interbedded silty to calcareous hematitic mudstone &amp; argillaceous, calcareous hematitic fine gr. sandstone</p>		

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.

LOGGED BY J. HULEN  
 J. GARDNER  
 SEPT. 13, 1988

GRAPHIC LOGS

THIS PAGE PRIMARY OF CORRELATED  
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DEPTH	ALTERATION										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRPTIONS
	QUARTZ SERICITE	SILICIFICATION	CHL	CHL	DISS PYRITE	FRACTURING	VEINING	VEIN-FILL	CLAY	OXIDATION			
3500'													3500-3505: MOTTLED, CALCAREOUS, HEMATITIC, FGR ss, prob. argillaceous, fairly silted.
3510'											many fix diped	3505-3515: argillaceous, hematitic, massive to very vaguely bedded sandstone w/ thin mudstone interbeds. local bleached/reduced spots up to at least 10 cm. wide - amoeboid bulbous.	
3520'												3515-3525: as above exc. well x-bedded, finer gr., more argillaceous.	
3530'											Nodular	3525-3527.5: mudstone, silty, hematitic, calcareous with irregular calcite nodules, ameboid up to 4-5 cm maximum dimension. scattered, bleached spots, many w/ cores of organic detrit.	
3540'												3527.5-3529.5: sandy mudstone to muddy sandstone (or siltstone), hematitic, calcareous w/ calcite nodules, as above, but much less common. calcite/limestone nodules are selectively fractured but healed; sparsely bleached as above.	
3550'											shear 40°	3529.5-3536.7: SANDSTONE-BRECCIA - 2, irreg. clasts of fairly clean med-gr. ss. up to at least 10 cm. dia., intricately invaded by stringers of muddy hematitic sandstone.	
3560'												3536.7-3539.7: MUDSTONE-SANDSTONE BRECCIA: 4 to subrounded clasts of variable hem. mudstone in a matrix of clean med. gr. sandstone - probably a lithic arkose; blue 5-7 cm co bleached lt. gray-green.	
3570'											VEIN 60 DIP CALCITE VEINLETS	3539.7-3542: interbedded muddy ss & sandy to silty mudstone, locally w/ calcareous nodules same as 3527.5 to 3535.0 ft.	
3580'												3542-3549.8: ss, f.g. massive exc. for lower 1/2 which is plane- to low- $\angle$ x-bedded; locally bleached, base is displaced 2-3 cm by fracture row occupied by calcite veinlet. Lower 3/4 cut by calcite veinlets up to 1 cm. wide - locally open.	
3590'												3549.8-3552.5: muddy, fine-gr. sandstone, locally w/ gray-green bleached spots up to at least 10 cm in dia. * @ in 3555 $\rightarrow$ 0.5' zone of oolitic-appearing nodules like this (centers are carbonate rich up to 1 cm. in diameter)	
3600'												3552.5-3571.5: interbedded sandy to silty mudstone & muddy fine-gr. ss as above.	
3610'												3571.5- ss, fg, massive to vaguely bedded well-sorted. * 3573.6-3573.9 - sandy mudstone as above.	
3620'													
3630'													
3640'													
3650'													
3660'													
3670'													
3680'													
3690'													
3700'													
3710'													
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3930'													
3940'													
3950'													
3960'													
3970'													
3980'													
3990'													
4000'													

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 NEW MEXICO



LOGGED BY J.B. HULEN  
 I.N. GARDNER  
 SEPT. 19, 1968

DEPTH	GRAPHIC LOGS											NOTES, COMMENTS	HEM. STAIN / RELATIVE INTENSITY	DESCRIPTIONS
	ALTERATION				FRACTURING	VEINING & VUGS - FILL.	MINERAL PHASES			GRAPHIC GEOLOGY				
	QUARTZ-SERICITE KMS	SILICIFICATION KMS	CHL KMS	DISS. PYRITE KMS			QUARTZ	SERICITE	CHLORITE		CALCITE			
3600														NODULAR CALCAREOUS MUDSTONE, DENSE, MOTTLED, LOCALLY APPEARING RECRYSTALLIZED; POSSIBLE SILKIFICATION, SERICITIZATION LOCALLY; ALSO COMMONLY a healed, brecciated appearance.
3610														3609-3613: As above except rx is a muddy siltstone to fine-grained sandstone, still hematitic & w/ calcareous nodules. Apparently less reworked than above.
3620														3613-3616: FINE-GR. massive hematitic to bleached, rel. "clean" sandstone. 3616-3623: hematitic, silty mudstone to muddy siltstone, calcareous, highly fractured; abundant nodules of calcite rounded to irregular, avg. about 5-7 mm. diameter.
3680														3623-3627: RECRYSTALLIZED, HORNFELS-K-APPEARING SLIGHTLY MUDDY LIMESTONE; mottled, brecciated/healed appearance, cut by numerous calcite veins & stringers of ft. optic green calcite plus (?) chlorite. (poss. w/ sericite as well)
3640														3627-3640: same as 366-3629.3; poss. slightly more silty.
3650														3640-3648: muddy-silty fine-grained hematitic sandstone calcite nodules as above, concentrated below 3642 ft.; locally bleached below 3644.
3660														3648-3656: med-gr. arkose, massive to prom. x-bedded, sericitized, prominent heavy mineral concentrations (ilmenite/magnetite), ser. concentrated toward top & bottom of unit.
3670														3656-3657: interbedded silty mudstone, sandy mudstone, & muddy siltstone, hematitic, variably calcareous, highly fractured, but fracturing probably diagenetic, induced temperature effect; local diagenetic bleaching/spotting, upper 7-13 mm bleached/sericitized at contact with overlying sandstone.
3680														3657-3677: SANDSTONE SAME AS 3641.0-362. bleached as above, sericitized toward lower contact.
3690														3677-3682: sandstone med. gr. as above, except (below 3682.5) there are prominent mid-strial laminae up to 3 mm. thick; still heavy mineral segregations.
3700														3682-3697.5: BRICK RED MUDSTONE, thermally fractured.
														3697.5-3700: LIMESTONE, dense, reworked, description next page.

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 NEW MEXICO -60-



LOGGED BY J. B. HULEN  
 SEPT. 15, 1968

SEPT. 16, 1988

LOGGED BY J. N. GARDNER  
J. B. HILLEN

DRILL HOLE VC-28 (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA

DEPTH	ALTERATION		VEINING & VES. FILL.	FRACTURING	DISSEMINATED MINERALIZATION	GRAPHIC GEOLGY	NOTES	DESCRIPTIONS
	CHL	HA						
9700								Limestone dense, v. thin, mottled, greenish-grey, with some green tinge. Has horizontal, concentric, and radial fracture patterns. Intrinsic reticulate network of hematitic mudstone "veins" accounting for <math>2-3\%</math> of the rock. Also cut by med.-df. grey siliceous mass. Lined, but at heights to core diam.
9700-9703.5								9700-9703.5: Calcareous hematitic mudstone, grada- tional upper & lower
9703.5-9708.5								9703.5-9708.5: TAME AS 9775-9700 conglomerate:
9708.5-9712								9708.5-9712: Interbedded calcareous hematitic mud- stone and clastic limestone (limestone sand, grit)
9712-9718								9712-9718: Interbedded hem. mudstone & shale, vari- ably sandy; local irreg. calcareous nodules up to of 1st. 5cm. max. diameter
9718-9728.5								9718-9728.5: Nodular calcareous hematitic mudstone, siliceous & fine sandstone (calc.); nodules irregular to angular up to at least 5 cm. dia. some nodules differentially fractured then re-healed.
9728.5-9733								9728.5-9733: Dense, apparent bedded, muddy fine- grained limestone L. reddish-brown & L. greenish- grey mottled to bedded/banded, reticulated texture. Poss. some neo-chlorite.
9733-9741.6								* 9733-9741.6: REPER. USED TO GREAT SLICE VEINING (MISSING UP TO APPARENTLY 20 CM DIA.) same as 9718-9728.5
9741.6-9749								9741.6-9749: SANDSTONE F.G. MASSIVE TO LOCAL E FINELY X-BEDDED. LOCAL BLEACH/REDUCED * 9749-9756: IRREG. LIMESTONE NODULE, SELECTIVE STRUCTURE FRACURED & REHEALED V. CALCITE
9756-9762								9756-9762: V.F.G. MASSIVE EXTENSIVE BEDDED/RE- duced shales - PUT MOTTLED, scattered calcite nodules up to at least 4 cm. dia.
9762-9768								9762-9768: Calcareous hematitic mudstone to siltstone, dense mottled, appearing, possibly partially rehealed/reworked, scattered calcareous nodules as above
9768-9775								* 9768-9775: Dominant rehn. & reformation of chlorite, perhaps other phases & reaction of carbonate nodules in matrix to form green- green tinge up to several mm. in diameter
9775-9786								9775-9786: as above, exc. muddy, f.g. sandstone v. calcareous nodules.
9786-9794								9786-9794: nodular calcareous mudstone & siltstone, roughly fine-gr. sandstone, hematitic, all calcareous nodules up to at least 10 cm in diameter, matrix appears to have reacted w/ muddy matrix (runs on nodules)
9794-9798								9794-9798: muddy matrix, hematitic, sparse nodules, calcareous

GRAPHIC LOGS  
PAGE NO. 61  
FIELD NO. VC-28  
DATE: 9/16/88

DESCRIPTIONS

NOTES

HEAT, RADIATION

DEPTH	GRAPHIC LOGS										GRAPHIC GEOLOGY	NOTES COMMENTS (EXC. VEINING)	DESCRIPTIONS
	ALTERATION		CHL	CAL	DISS. PYRITE	FRACTURING	VEINING & VUG-FILL	VEINLET PHASES					
	SERICITE	MUSC./FILICHA						GLAUSZ	SERICITE	CHLORITE			
3800'												HEM. SPOTS & STRINGERS	3802.4-3815: calcareous, hematitic mudstone to siltstone - mottled & locally dense & recrystallized - appearing (see previous page); below 3807 thin - chert bleached/reduced spots; mms w/ dark centers (organic debris?); nodular below in 3810 as in overlying units.
3810'												REXLD?	3819-3822: v.f. GR, hem, sparsely calcareous, argill. to silty sandstone, mottled, locally bleached/reduced.
3820'													3825.3-3830.1: calcareous, hematitic mudstone mottled, recrystallized, appearing; microbrecciated/reduced texture locally; cut by radiating oriented stockwork veins, apparently of hematite silica (?) & calcite; lower 2 1/2 ft. nodular.
3830'												partly reduced; nodular	3830.1-3835: limestone v. f. ch., argillaceous, sparsely hematitic, v. lt. pinkish to greenish-gray; poss. partly recrystallized.
3840'													3835.5-3842.8: same as 3830.1-3835.1
3850'													3842.8-3847: shale, hem, highly fissile, extremely fractured but this may be drilling-induced in part.
3860'												✓ for chl-calc veins f. nodules ss, white, ser. chl. sil.	3847-3851: as above, except silty & locally sandy due to green chl veins w/ calcite selvages. med. gray-green nodules up to 3 cm. in diameter should check these for ACTINOLITE 385-3855.2': interbedded sandy mudstone to siltstone & med-gr. ss. ss's are sericitized, calcitized, selectively.
3870'													3855.2-3860.8: argillaceous-silty hem. ss. f. gr. ss beds here selectively bleached/sericitized; some diagenetic reduction/spalling locally 3860.8-3865.7: clean bleached, med. gray-green siltstone vaguely plane- to X-bedded sericitized, scattered hem. argillaceous interlamination
3880'													* 3871.5-3872.1: CHL-CAL veinlet offset beds in 2 cu.
3890'													* 3897-3898.5: slumped bedding? dips as high as 60°
3900'													* 3898-3899.6 ft → abundant shale np-ups bleached (ser-chl); lt. gray-green
3910'													* 3899-3902: 5-10 mm. clastic dibe 70° dip flake like, more stained than matrix otherwise texturally identical.
3920'													3899.3-3912: hem., silty, calcareous mudstone as above

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 NEW MEXICO -62-

LOGGED BY J. B. HULEN  
 SEPT. 16, 17  
 1968



**GRAPHIC LOGS** \*\*CAL\*\* COLUMN THIS PAGE REFERS TO PRIMARY & DIAGENETIC CARBONATE (EXC. VEINS)

NOTE GOOD CORRELATION OF FRACTURING & FISSILE MUDSTONES - THESE PROBABLY DO NOT PROVIDE THROUGHGOING PERMEABILITY.

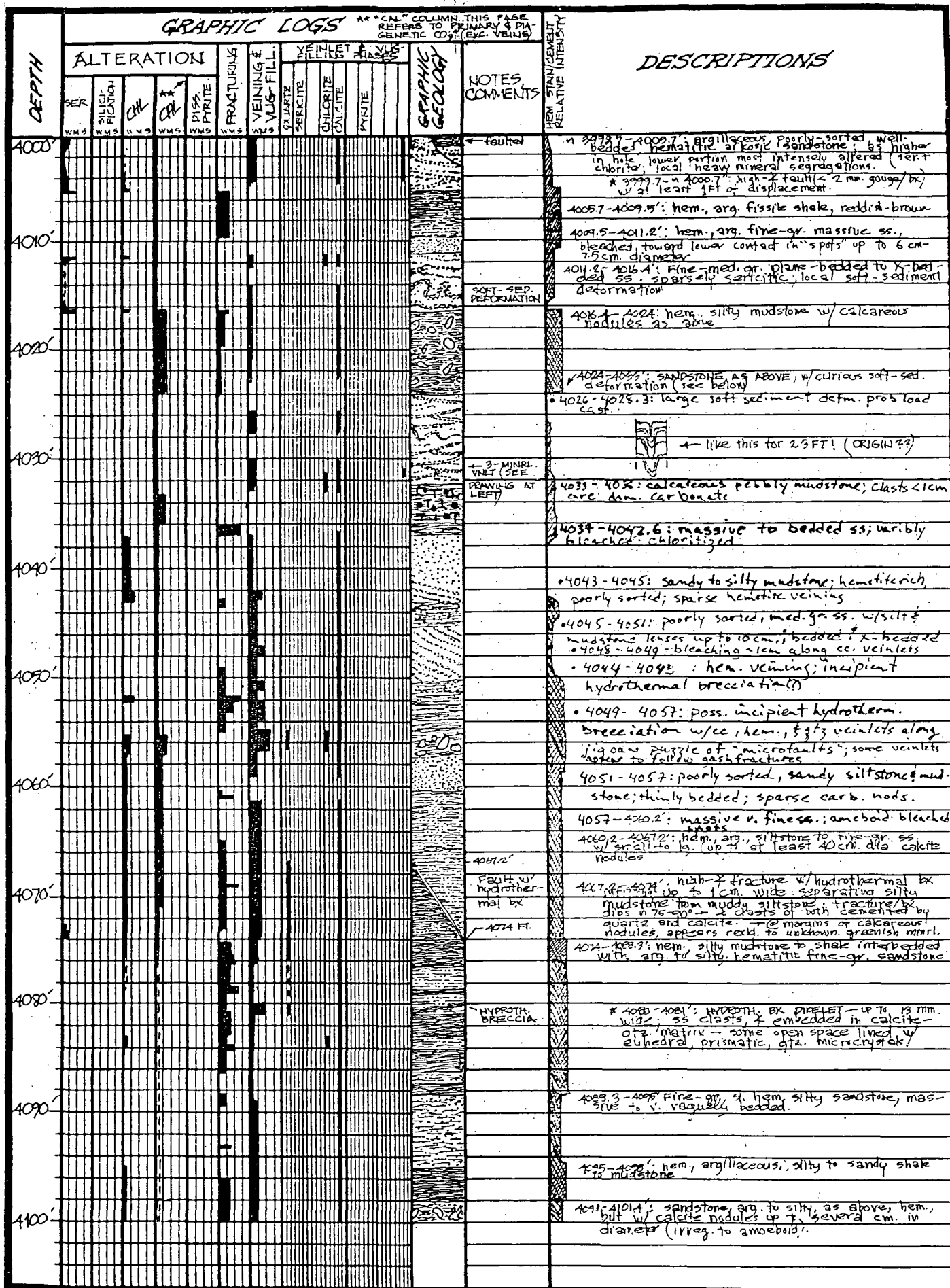
**DESCRIPTIONS**

DEPTH	ALTERATION					FRACTURING	VEINING & VUG-FILL	MINERAL PHASES				GRAPHIC GEOLOGY	NOTES COMMENTS	HEM. VEINING INTENSITY	DESCRIPTIONS
	EPICLITE	CLAUDE	CHL	CA	DISS. PYRITE			QUARTZ	PERCITE	ILLORITE	CAICITE				
3900															HEMATITIC MUDSTONE TO SILTSTONE, AS ABOVE FISSILE. HIGHLY FRACTURED, BUT FRACTURES MAY BE DRILLING-INDUCED.
															* 3909.7-3905.7: irreg. hematitic "blooms", matrix much darker than red-orange matrix - these up to 20 mm. dia.
3910															3912-3911: hem. arg. silty sandstone, massive, locally bleached/reduced to lt gray/green.
															3919-3917: med.-gr. X-bedded, partially sericitized weakly hematitic sandstone
3920															NOTE HIGHEST INTENSITY SERICITIZATION AT BASE OF UNIT - PROB. REFLECTS COARSER GRAIN SIZE & HIGHER PRIMARY POROSITY.
															mod. abund hem. & cal. vnlts - cal. post-dates (X-cuts) hem. vnlts. chloritic selvages assoc. w/ calcite vnlts. - hem. veining could be diagenetic.
3930															3937-3945: calcareous mudstone dense, mottled, hematitic, mottled, locally microbrecciated/rehealed, cut by med. gr. irred. vnlts & patches which could be siltst. local calcareous nodules up to at least 5 cm. dia.
3940															3946.5-3952: same as 3930.1-3933.3 bxta/rehealed texture (reticulated)
3950															3952-3955 Nodular, sl. calc, hem. mudstone to shale
															3959.5-3963: hem. arg. f.igr. ss. to coarse siltstone
3960															3968-3974: ss, f-m grained, locally bleached/sericitized but predom. hematitic. massive to prom. X-bedded.
3970															MUDSTONE
															MUDSTONE
															3974-3976.7: FISSILE SHALE, hem, highly fractured.
3980															3976.7-3980.2: interbedded arg. hem. siltst. & med.-gr. ss - some bleached, some still hematitic.
															* 3979.7-3978.9: QTZ-CEMENTED BRECCIA w/ gssu fractures - rare prismatic qtz. xls. in open frags.
															UPWARD-FINING SANDSTONE
															3980.2-3989: med.-cr. gr., upward-fining arg. sandstone, vaguely X-bedded to massive, sericitized (particularly toward base); beds dip up to 30°
3990															dip 5-30° CWC
															3989-3993.8: hem. arg. siltstone.
															3993.8-3997.6: same as 3980.2-3989
4000															MICROFLINT CONTACT DO FAULT ZONE (SEE WEST P.)
															3997.6-3999.7: interbedded arg. siltstone & sandstone - hematitic

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 NEW MEXICO.



LOGGED BY J.B. HULEN  
 J.N. GARDNER  
 SEPT. 17, 1988



DRILL HOLE VC-7B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM

LOGGED BY J.B. HULEN & J.N. GARDNER  
SEPT. 17, 18, '88



# GRAPHIC LOGS

DEPTH	ALTERATION										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS	
	QUARTZ		CAL		DISS. PYRITE		FRACTURING	VEINING & VUG-FILL		VEINLET FILLS				
	WMS	WMS	WMS	WMS	WMS	WMS		QUARTZ	SERICITE	CHLORITE				CALCITE
1100'													STRONG ALTN.	4104-4106: arg. siltstone to f. gr. sandstone, highly bleached/alt. upper 0.7 ft. to light gray-green prob. chlorite-ser
1110'														4106-4117: F-m gr. ss, locally silty to arg., fining upward; chlorite, ser below 4108.3; bedding ranges from massive to pram. x-bedded some bleaching/reduction in amplitude spots.
1120'													REXLEN. DOLOMITE REXLEN.	* basal 2' strongly bleached, sericitized, soaked w/ calcite → are so affected 4117-4118.7: nodular dolomitic mudstone, partly nodat.; dol. nodules up to 3-4 cm. dia w/ gray-green rims up to 5 mm. wide 4118.7-4120.3: DOLOMITE, lt. greenish-gray, v. f. xln., poss. silty; has "porphyritic" appearance w/ lt. gray to orange-gray irides, more coarse-grained. clots. up to 3-4 mm. in diameter. 4120.3-4122: CALC. MUDSTONE, prob. rext., mottled w/ brecciated/rehealed texture; reformation of nod. gray-green mineral 4122-4125: hem. argillaceous siltstone to sandstone 4125-4127: mudstone/shale 4127-4128: sandstone, f. gr. massive, altered 4128-4130: arg., heavy siltstone 4130-4131: s. v. f. xln., lt. gray 4131-4137: arg. to silty clay, to calcareous siltst. 4137-4147.8: mudstone, locally extremely fissile, local irreg. calcitic blebs up to 5-6 cm. dia.
1130'														4147.8-4148.6: DOLOMITIC MUDSTONE TO ARGILL. DOL. MOTTLED, W/ IRREG. DOL + CHL. "NODULES" UP TO 1.5 CM. DIA. SOME OF THESE APPEAR TO HAVE CHLORITIC RIMS.
1140'														4148.6-4150.2: DOLOMITE, massive, lt.-med greenish-gray looks "speckled" under hand lens - local calcite nodules or concretions up to 1 cm. dia.
1150'														4150.2-4150.9: CALC. MUDSTONE AS ABOVE
1160'														4150.9-4151.6: DOLOMITE, AS ABOVE 4151.6-4152.8: med. gray fissile shale 4152.8-4153.8: calcar. siltst., lower one ft. heavily veined w/ prob. diagenetic calcite-reticulate texture 4153.8-4173: argill. locally calcareous siltstone, rare calcareous nodules.
1170'													bed. dip 5-10°	4173-4174.5: fissile mudstone 4174.5-4175: dolomitic mudstone 4175-4179: massive gray dolomite as above 4179-4180.5: GRAY, fissile dol. mudstone 4180.5-4181: mottled, calc. mudstone w/ 10% chbr/ cal. nodules. 4181-4183: dol., AS ABOVE 4183-4189.5: GRAY, CALCAR., HIGHLY FISSILE SHALE 4189.5-4186.2: CALC. MUDSTONE 4186.2-4196: Calc. mudstone, red again, with local, irreg. concretions up to 12 cm. dia. • 4186.2-4188.5: reticulate network of stockwork calcite veins
1180'														4196-4200: lenticular bedded, interbedded, f. gr. sandstone & argillaceous siltstone, interbedded gray & red coloration
1190'														
1200'														

NOTE: FRACTURING SHOWS GOOD CORRELATION WITH FISSILITY OF MUDSTONES/SHALES. THIS TYPE OF FRACTURING PROBABLY DOES NOT PROVIDE THROUGHGOING PERMEABILITY.

## DESCRIPTIONS

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM



LOGGED BY J. HULEN & J. GARDNER  
 27 SEPT, 9 DEC '80

GRAPHIC LOGS

DEPTH	ALTERATION					FRACTURING	VEINING & VLS-FILL	VEINLET	VLS PLACES	GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS
	CHL	CR	DISP. PYRITE	FRACTURING	VEINING & VLS-FILL							
4200												4200-04: v. fissile, reddish-brown shale w/ sparite, reduced, white spots
4210												4204-4207: arg. lenticular bedded, red-brown siltstone, local irreg. bleached/reduced zones, many sub-// to bedding 4207-4211: arg. silt. to sandstone (f. gr.), lower 2' partially (10%) bleached/reduced in irreg. spots. 4211-4214: wavy to lenticular-bedded arg. to silty fine-gr. sandstone 4214-4216: mottled, 30% bleached, argillaceous to silty fine-grained sandstone 4216.1-4220: same as 4207-4211
4220												4220-4222.5: same as 4211-4214 4222.5-4225: same as 4200-4204 4225-4228.7: massive, lt. greenish-gray fin. sand dolomite grading downward into dolomitic sandstone & below in 4221' calc. nodules, irreg., up to 4 cm. dia, rimmed w/ chlorite.
4230												4228.7-4231.3: massive lt. gray, f-med. gr. locally calcareous sandstone 4231.3-4232: red-brown calcareous siltstone 4232-4236.1: Nodular, lt. gray-green, fossiliferous limestone. 4236.1-4239.5: irreg., 1-3 mm calcite veinlet, 60 dip 4239.5-4241: spotted, arg. to silty, reddish-brown fine-gr. ss. spots are rel. richer in hem. 4239-4239.5: massive, lt-med. reddish-brown, med-gr. ss. 4239.5-4241: same as 4236.1-4238.
4240												4241-4241.5: shale, fissile, red-brown 4241.5-4244: massive, slightly brownish-gray micritic limestone 4244-4245: argillaceous, med. hem. micritic limestone, locally mottled w/ reduced/bleached spots. 4245-4246: As above, but only sparsely micritic - nodular & concretionary @ 4245.5 FT. FAULT BETWEEN ABO & MADERA DIP 70°
4250												4246-4247: massive limestone, micritic w/ coarse irreg. pellets, rare stylolites, locally disrupted by irreg. calc. v. & hydrothermal breccias. (see drawing) 4247-72.8 argillaceous, fossiliferous, wavy-bedded micritic limestone, alternating rel. pure micrite & argillaceous micrite, latter locally partly cherted, fossils partially replaced to spar - include brachiopods, pelecypods(?), horn corals, (fossil) fragments, whole fossils rare. fossil frags. up to 3 cm. long 4271.8-72.8: wk. to tr. diss. py in carbonaceous residue in large fossil frags. 4272.8-4282.8: lt-med. sl. greenish to brownish gray faintly mottled massive MICRITE, poss. sparse fossil "ghosts" < 0.9 cm.
4260												4252.5-4262: massive limestone, micritic w/ coarse irreg. pellets, rare stylolites, locally disrupted by irreg. calc. v. & hydrothermal breccias. (see drawing) 4262-72.8 argillaceous, fossiliferous, wavy-bedded micritic limestone, alternating rel. pure micrite & argillaceous micrite, latter locally partly cherted, fossils partially replaced to spar - include brachiopods, pelecypods(?), horn corals, (fossil) fragments, whole fossils rare. fossil frags. up to 3 cm. long 4271.8-72.8: wk. to tr. diss. py in carbonaceous residue in large fossil frags. 4272.8-4282.8: lt-med. sl. greenish to brownish gray faintly mottled massive MICRITE, poss. sparse fossil "ghosts" < 0.9 cm.
4270												4262-72.8 argillaceous, fossiliferous, wavy-bedded micritic limestone, alternating rel. pure micrite & argillaceous micrite, latter locally partly cherted, fossils partially replaced to spar - include brachiopods, pelecypods(?), horn corals, (fossil) fragments, whole fossils rare. fossil frags. up to 3 cm. long 4271.8-72.8: wk. to tr. diss. py in carbonaceous residue in large fossil frags. 4272.8-4282.8: lt-med. sl. greenish to brownish gray faintly mottled massive MICRITE, poss. sparse fossil "ghosts" < 0.9 cm.
4280												4282.8-4286: nodular, arg. calc. hem. siltst. irreg. calcite nodules up to at least 10 cm. dia. or length (bloom-like) Throughout this unit - irreg. high- & hydrothermal lx veins, anastomosing, up to 2 cm. wide 4286-4299: nodular, poss. argillaceous massive micrite, slightly brownish to greenish-gray, cal. nodules, bloom-like, up to at least 1 cm, bxd. cal. v. rimmed with chlorite 4299-39.9: silicified zone, concordant, v. lt. gray to greenish-gray, cut by veinlets of silica, chl. py. Calcite in various combinations, poss. other sulfides, bedding faintly preserved. 4299.9-4296.9: QUARTZ-CALCITE-ROCK FLOUR VEIN, UP TO AT LEAST 6 CM WIDE; MOSTLY GRAY-GREEN SANDY ROCK FLOUR, 4299.9-4294.9 & FROM 4296.2-4296.5, V. THIN CALCITE (TO 12) SELLAGE; FROM 4294.9-4296.2 - locally vuggy, vugs up to 6 cm. dia. lined w/ cub. rhombohedral calcite, prismatic qtz. & 1/2% - 1% "fishscale" calcite w/ gray-green chlorite & phenocryst-pyrite. vein is 1/4" dia. but dips about 80°
4290												4282.8-4286: nodular, arg. calc. hem. siltst. irreg. calcite nodules up to at least 10 cm. dia. or length (bloom-like) Throughout this unit - irreg. high- & hydrothermal lx veins, anastomosing, up to 2 cm. wide 4286-4299: nodular, poss. argillaceous massive micrite, slightly brownish to greenish-gray, cal. nodules, bloom-like, up to at least 1 cm, bxd. cal. v. rimmed with chlorite 4299-39.9: silicified zone, concordant, v. lt. gray to greenish-gray, cut by veinlets of silica, chl. py. Calcite in various combinations, poss. other sulfides, bedding faintly preserved. 4299.9-4296.9: QUARTZ-CALCITE-ROCK FLOUR VEIN, UP TO AT LEAST 6 CM WIDE; MOSTLY GRAY-GREEN SANDY ROCK FLOUR, 4299.9-4294.9 & FROM 4296.2-4296.5, V. THIN CALCITE (TO 12) SELLAGE; FROM 4294.9-4296.2 - locally vuggy, vugs up to 6 cm. dia. lined w/ cub. rhombohedral calcite, prismatic qtz. & 1/2% - 1% "fishscale" calcite w/ gray-green chlorite & phenocryst-pyrite. vein is 1/4" dia. but dips about 80°
4300												4282.8-4286: nodular, arg. calc. hem. siltst. irreg. calcite nodules up to at least 10 cm. dia. or length (bloom-like) Throughout this unit - irreg. high- & hydrothermal lx veins, anastomosing, up to 2 cm. wide 4286-4299: nodular, poss. argillaceous massive micrite, slightly brownish to greenish-gray, cal. nodules, bloom-like, up to at least 1 cm, bxd. cal. v. rimmed with chlorite 4299-39.9: silicified zone, concordant, v. lt. gray to greenish-gray, cut by veinlets of silica, chl. py. Calcite in various combinations, poss. other sulfides, bedding faintly preserved. 4299.9-4296.9: QUARTZ-CALCITE-ROCK FLOUR VEIN, UP TO AT LEAST 6 CM WIDE; MOSTLY GRAY-GREEN SANDY ROCK FLOUR, 4299.9-4294.9 & FROM 4296.2-4296.5, V. THIN CALCITE (TO 12) SELLAGE; FROM 4294.9-4296.2 - locally vuggy, vugs up to 6 cm. dia. lined w/ cub. rhombohedral calcite, prismatic qtz. & 1/2% - 1% "fishscale" calcite w/ gray-green chlorite & phenocryst-pyrite. vein is 1/4" dia. but dips about 80°

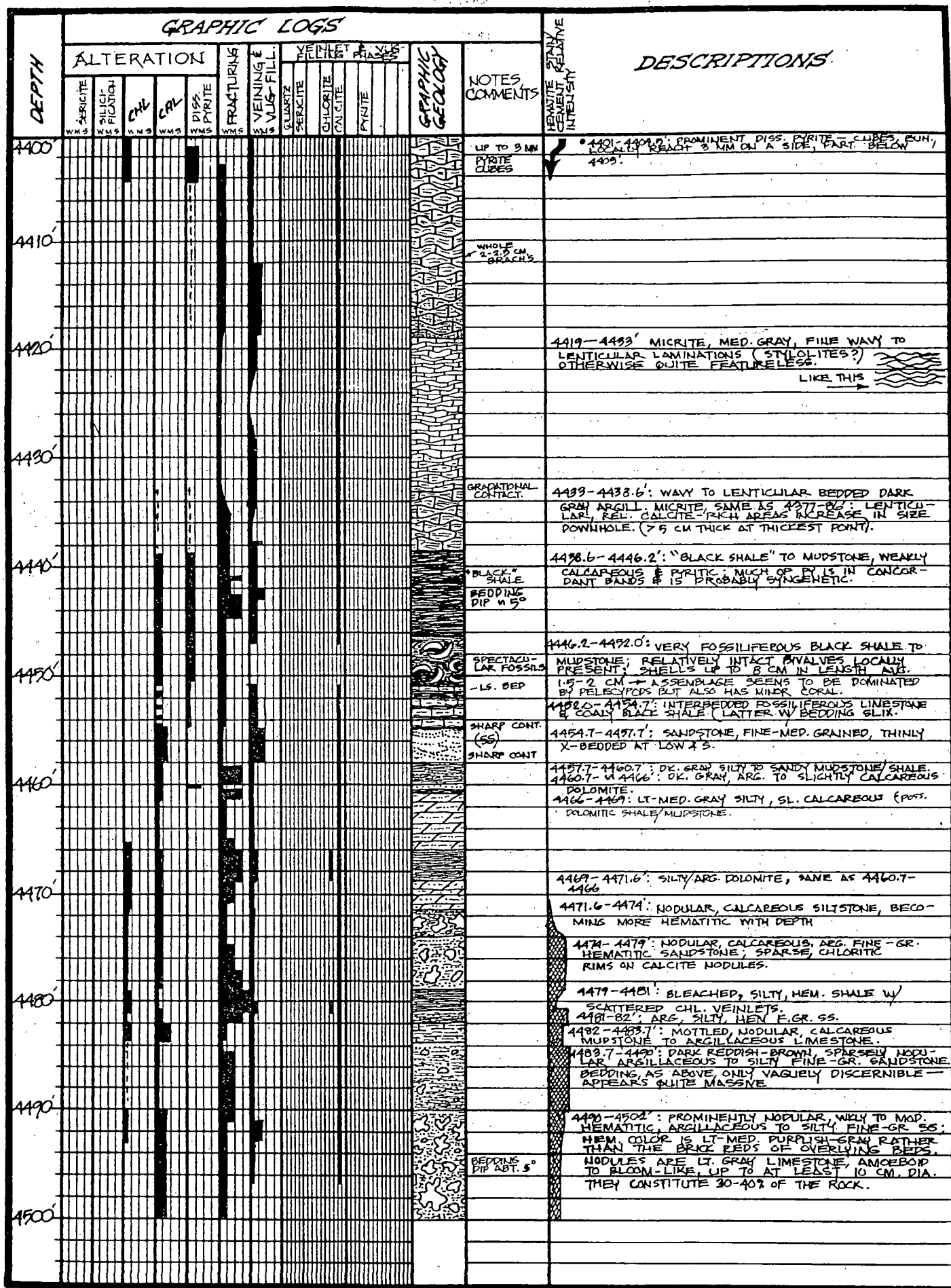
DRILL HOLE VC-2B (FIELD LOG)  
LOCATION VALLES CALDERA, NM

LOGGED BY J. HULEN & I. GARDNER  
9 & 10 DEC. 1983

DEPTH	GRAPHIC LOGS										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS		
	ALTERATION					FRACTURING	VEINING & VUG-FILL	YEINLET FILL						FACIES	
	SERICITE	SILICIFICATION	CHL	CA	DISS PYRITE			QUARTZ	SERICITE	CHLORITE					CALCITE
4900															4900.5-4907.5: Interbedded med. xln. bioclastic limestone and med. gray argillaceous micrite. * 4905.5-4906': calcite veins & calcite-cemented hydrothermal breccias up to 7 mm. wide. argillaceous
4910															BEDS DIP 4907-4911: med.-dk. gray, massive, micritic limestone; poss 1-2% dark, diss. argenic debris. Flocks mostly < 1 mm. dia; local calcite nodules up to or least 10 cm. dia. 4911-4916: lt. gray med. xln. mostly massive bioclastic limestone (fossil. wash); note crinoid; brachiopod, bryozoan fragments. 4916-4925: same as 4907-4911
4920															ORGANIC-RICH (DK. GRAY) * 4918.5-4919.5 FT.: IRREG. CALCITE-CEMENTED HYDROTHERMAL BRECCIA VEINS UP TO 15 MM. WIDE + V. FOSSILIFEROUS
4930															ABUNDANT PYRITIC CAL. VNS. 4925-4928: Nodular, contorted, highly cal. veined, py-rich prob. argill. Limestone, locally 5 or more % diss. pyrite; irreg. multiply-disrupted cal + py veins up to 20 mm. wide! 4928-4930: LT. GRAY BIOCLASTIC LS., AS ABOVE. 4930.5-4932.5: Fossiliferous, argillaceous, wavy to lenticular bedded micritic limestone. 4932.5-4938.5: As above, but interbedded with lt. gray bioclastic limestone, same as 4911-16'
4940															4938.5-4948.5: Nodular, lenticular bedded, lt. gray, sl. argillaceous micritic limestone. * 4944.7-4946.5: HYDROTHERMAL BRECCIA ZONE. IRREG. HIGH-ANGLE BK. DIVES & STRINGERS UP TO 6.5 CM. WIDE (WHOLE CORE) + CLASTS OF MATRIX MICRITE CALCITE VEIN MATERIAL IN LOCALLY PYRITIC, DARK GRAY CALCITE (MICROLIN) MATRIX.
4950															HEALED FAULT BK. 4948.5-4951.1: HEALED BY PROB. TECTONIC - 4 CLASTS OF 15. IN. CALCITE MATRIX (MICROLIN). 4951.1-4959: interbedded dk. gray, presumably organic-rich, micritic & locally fossiliferous & argillaceous limestone and lighter gray micrite to med.-xln. bioclastic limestone
4960															BEDS DIP 4.5-10° 4959-4966.5: Med.-dk. gray org(?) -rich, pellet(?) bearing sl. argillaceous micritic limestone. locally tending toward fissility
4970															RED 4966.5-4969.5: nodular, sl. hematitic, spotted-appearing argillaceous micrite. 4969.8-4970.8: CAL., SL. HEM. SHALE * VEINS ONLY FILL 4970.8-4972: CONSPICUOUSLY NODULAR LT. GRAY-GRN. ARGILL. TO SILTY MICRITE. NODULES "BLOOM-LIKE", UP TO AT LEAST 10 CM. DIAMETER. SHRINKAGE CRACKS IN CONCRETIONS 4972-4977: CONSP. NODULAR, HEMATITIC & CALCAREOUS V.F. GR. ARG. TO SILTY SS (LOOKS LIKE ABO)
4980															RED 4977-4986: DISTINCTIVE, nodular to lenticular-bedded argillaceous micrite; lt. to v. light gray w/ arg. stress slightly brownish
4990															RED 4986-4987.5: CALCAREOUS, FISSILE, HEM. SHALE. 4987.5-4990.2: HEMATITIC, LOCALLY NODULAR, STRONGLY ARGILLACEOUS LIMESTONE. 4990.2-4991.8: SPOTTY, LT. BRN-GRY ARG.(?) MICRITE 4991.8-99: SAME AS 4977-4986'
4400															RED 4993-4997: SAME AS 4977-4986', EXCEPT PURPLISH, HEMATITIC, ARGILLACEOUS MATRIX 4997-4419: SAME AS 4977-4986'

DRILL HOLE VC-2B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM

J. HULEN &  
LOGGED BY J. GARDNER  
10 DEC. 1988



DRILL HOLE VC-2B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, N.M.

LOGGED BY J. HULEN  
10 DECEMBER  
1988

GRAPHIC LOGS										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS	
DEPTH	ALTERATION					FRACTURING	VEINING & VUG-FILL.	YEILITE FILLING					
	CHL	OR	DISS	PIRIT	CHLORITE			CHLORITE	PIRIT				ORGANIC
4500'												4502'	4502'-4503.5': sparsely nodular, sl. calc. w/ fly hem. siltstone, becoming less hem. w/ depth.
4510'												4503.5'-4506.5'	4503.5'-4506.5': Nodular, calc. siltst., mod. cal ± chl. veining.
												4506.5'-4510.2'	4506.5'-4510.2': med. dk. gray, lent. X-bedded calc. siltst. becoming more calc. w/ depth.
												4510.2'-4511.7'	4510.2'-4511.7': lower 1' sparsely fossiliferous. Med. gray bioclastic ls. w/ brachi. crinoids.
4520'												4511.7'-4517.5'	4511.7'-4517.5': DARK GRAY, SPARSELY NODULAR, well-bedded laminated, calcareous & argillaceous siltstone, prob. organic-rich & w/ minor diss. pyrite (syngenetic?) becoming more abundant w/ depth. 1' below 1st = sparse, <2mm concordant pyrite bands.
												4517.5'-4519.4'	4517.5'-4519.4': "BLACK SHALE": dk. gray, org. and pyrite-rich fissile shale to mudstone.
												4519.4'-4525.5'	4519.4'-4525.5': MICRITE, med. gray, stylolitic, mod. abundantly veined w/ py. cal. org. debris. 2' hyd. bk. upper 2' w/ disrupted cal. v. int. material.
4530'												4525.5'-4530'	4525.5'-4530': SAME AS 4517.5'-4519.4'
												4530'-4539.5'	4530'-4539.5': DL. GRAY, ORG. & PY-RICH MASSIVE MICRITE.
												4539.5'-4542'	4539.5'-4542': INTENSELY OXID. w/ DISCONTINUOUS S.S.P. VEINETS ORIENTED 2' W 60° TO CORE AXIS.
4540'												4542'	4542'-4547': MUDSTONE v. soft but non-fissile, mottled, w/ rivet diss. hem. & chert. Scattered calc. nodules w/ chl. rims. hem. stain.
												4547'	4547'-4576.5': INTERBEDDED lt. gray argill. cal. calc. & mudstone to siltstone & lt. gray to reddish-gray bioclastic limestone (fossil wash). These up to 1.5 cm thick. Silt. calc. beds, conspicuously chertitic. many ls. beds pinkish, w/ky hematitic.
4550'												4576.5'	4576.5'-79': arg. ls. fossiliferous, wavy-bedded, convolute-bedded.
4560'												4579'	4579'-4583.8' MICRITE, med. gray, convolute-bedded.
												4583.8'	4583.8'-4574.5': MUDSTONE variably calcareous, more so toward top of unit - actually interbedded w/ micrite toward top; sparsely fossiliferous.
4570'												4574.5'	4574.5'-79': HIGH-2 HYDRATH, PRECIPITATED IN 1/2" - 3/4" WIDE, CEMENTED W/ MED.-XLM CALSITE - ONE VUG AT TOP 2 CM WIDE, LINED W/ RHOMBIC CALSITE KLS. UP TO 7-R MM.
												4574.5'	4574.5'-79': HIGH-2 HYDRATH, PRECIPITATED IN 1/2" - 3/4" WIDE, CEMENTED W/ MED.-XLM CALSITE - ONE VUG AT TOP 2 CM WIDE, LINED W/ RHOMBIC CALSITE KLS. UP TO 7-R MM.
4580'												4577.1'	4577.1'-4585.2': Hematitic, fining-upward, silici-clastic sequence - as drawn to left, med. sand upward through fine sand to siltstone.
												4585.2'	4585.2'-79': calcite nodules rimmed w/ chl. - also chl. v. int. - some nodules fractured, pty filled w/ med.-xlm. calcite.
												4587.4'	4587.4'-4593.0': Mottled mudstone, sparsely chertitic hematitic; lower 3' mod. abund. calcite nodules, many rimmed w/ chlorite in part.
4590'												4593'	4593'-4598.4': NOODULAR, hem. mudstone to siltstone. bloom-like cal. nodules as above, many rimmed with chl.
4600'												4598.4'	4598.4'-4600': plane-bedded, med. gr., locally muddy to silty sandstone.

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM

LOGGED BY HULEN & GARDNER  
 12 DEC., 1988



DEPTH	ALTERATION											GRAPHIC GEOLOGY	NOTES COMMENTS	CHEM. STAIN CEMENT, REL. INTENSITY	DESCRIPTIONS							
	SERICITE		SILICA FUSION		CHL		CAL		PISS PYRITE		FRACTURING					VEINING & VES-FILL		VEINLET		FRAGMENTS		
	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS					WMS	WMS	WMS	WMS	WMS	WMS	WMS
4600																				4600-4611.7: INTERBEDDED CALCAREOUS, LOCALLY NODULAR MED-F GR. SANDSTONE, SILTSTONE & MUDSTONE, BECOMES MORE CALCAREOUS IN GENERAL WITH DEPTH. LOCALLY MOD. ABUND. DISS. PYRITE IN MORE ARGILLACEOUS BEDS.		
4610																				4611.7-4618: thickly convolute bedded, med. gray, arg. to silty micrite. 4618-15: 65-70° dipping 4-20 mm. fishscale calcite vein - open at widest portions		
4620																				4618-4620.2: nodular, calcareous, wavy-bedded, calcareous siltstone, lt. med. gray 4619.6-4620.4: "tempestite" w/ 1-15 mm. med. gray calcite clasts 4620.2-4622.3: massive, med. gray, argillaceous siltstone, very pyritic, diss. silty grains < 0.2 mm - locally coalesced as irreg. clots up to 2 cm. dia. 4622.3-4626: lt. gray, massive, f. gr. ss, sl. calcareous, bec. finer-gr. w/ depth 4626-4628.5: v. wkly hematitic, organic-rich, argill. siltstone w/ diss. py euhedra up to 5 mm. dia. 4628.5-4630.9: ss, as above		
4630																				4630.9-4636.5: FINING-UPWARD SILTCLASTIC SEQUENCE, MED. GRAY, SS TO SILT. 4636.5-4637.5: gray, laminated mudstone 4637.5-4638: nodular, calcareous, gray f. gr. ss. to siltst.		
4640																				4638-4648: lt. gray, med. gr. massive to low-angle x-bedded sandstone w/ widely scattered argillaceous partings, many w/ rel. coarse muscovite.		
4650																				4648-4650: MED-DR GRAY, THINLY (2-20 MM)-BEDDED SILTY SANDSTONE - BEAUTIFUL PYRITE BANDS & FLAT LENSES UP TO 0 MM. THICK WITHIN 0.4' OF UPPER CONTACT. 4650-4652.5: QTR-RICH MUDSTONE, MED. GRAY, PROMINENT PY VEINLETS UP TO 3 MM. WIDE		
4660																				4652.5-4661.5 FT.: LIMESTONE BRECCIA, lt.-med. gray clasts in a med-locally dk. gray matrix. clasts are mostly fossiliferous v. r. xln. limestone - subz to rounded up to at least 25 cm. in diameter, matrix contains significantly more organic & argillaceous debris; calcite veinlet 15 mm. wide 4659.5-4661.5 some clasts at top of unit are themselves intraformational breccia. 4661.5-4665: v. FOSSILIFEROUS, CONTACT-BEDDED, ARGILLACEOUS LIMESTONE - alternating dark gray arg. beds & thicker, lighter gray micrite. most fossils in arg. zones. 4665-4675: v. dk. gray, arg.-rich & fossiliferous calc. mudstone - coral frags. v. common.		
4670																				4665.5-4671.7: med. gray, argill., locally v. fossiliferous, micritic limestone; corals abundant. widely scattered 1-10 mm arg-rich beds.		
4680																				4671.7-4681.7: SANDSTONE, LT-MED. GRAY, THINLY PLANE-TO LENTICULAR (FLASBY)-BEDDED, BECOMING MORE ARG. & ORGANIC-RICH W/ DEPTH. 4681.7-4683: DK. GRAY, FINELY-LAMINATED, ORGANIC & PYRITE-RICH SILTY MUDSTONE; 5% PYRITE, V.V. FINE-GRAINED, CONCENTRATED IN CONCORDANT BANDS & LENSES UP TO 12 MM. THICK - some irreg. clots as well 4683-4687: DK. GRAY, ORG-RICH, PELLOID-BEARING MICRITE, MASSIVE 4687-4691: SAME AS 4611.7-4618. med. xln. cal. v. lt. irreg. but essentially vertical, up to 1/2 in. wide, cut by 2nd generation of cal. knits, commonly banded 4691-4698.4: VARIABLY NODULAR, ARG. SILTSTONE, also varies in color from purplish-brown through lt. gray-green		
4690																				4691.7-4698.4: VARIABLY NODULAR, ARG. SILTSTONE, also varies in color from purplish-brown through lt. gray-green		
4700																				4698.4-4699.5: med. gr., lt. gray bioclastic limestone 4699.5-4700.6: nodular, same as 4691-4698.4 both purplish-red & lt. gray-green.		

DRILL HOLE VC-2B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA, NM

J. GARDNER  
LOGGED BY J. HILLEN  
SEPT. 27 1988  
DEC. 12,

GRAPHIC LOGS										GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS	
DEPTH	ALTERATION					FRACTURING	VEINING & VLS-FILL	VEINLET PLUGS	FRASSES				
	SEXT	PHYLIC	CHL	CHL	DISS								
4700	4700	4700	4700	4700	4700	4700	4700	4700	4700				
4700											4700.6-4702.7: Massive, lt-med. gray, fusulinid-bearing micrite, poss. arg.		
											4702.7-4707.4: Mottled, lt. gray-green w/ sparse argill. red mudstone to shale chl. mottling & veinlets.		
4710											4707.4-4709.2: SLTSTONE, massive lt. gray-green, cherty, laminated, concretionary. Gr. sand at base.		
											4709.2-4711: nodular to massive, locally concretionary bedded, argillaceous limestone locally red. argill. beds mod. cherty.		
											4711-4713.4: Lt. gray-green, vaguely layered, bedded, f-med. gr. ss, concretionary & bio-tubulated to worm pp.		
4720											4713.4-4716.3: Nodular, calcareous argill. & cherty v.f. arg. sandstone - calcite nodules up to 20% of rock - locally up to 9% di. py. grains 2.0-2 mm.		
											4716.3-4719.8: RECRYSTALLIZED V. LT. GRAY V.F. KLN. SYNOPTIC (ABUND.) Limestone also abundant red. fossils & fossil frags (marine inverts - brachiopods, fusulinids, etc.)		
											4719.8-4721.7: DENSE LAM. TO FINELY LENTICULAR-BEDDED cherty argill. siltstone to silty mudstone of argillite.		
4730											4721.8-4727.7: arg. cherty, pyritic, thickly laminated arg. siltstone to arg. gr. ss. locally abundant diss. py. microlites - up to 5%.		
											4727.7-4728.8: sandstone massive to thinly plane-bedded, locally coarse gr. to argill. - 4734-35 - 1.5 m. cal. & arg. cherty to v. 4734.		
4740											4728.8-4740.5: wavy/concretionary bedded argill. Limestone.		
											4740.5-4749: med. gray-green, lam. to massive siltstone.		
											4749-4746.3: fossiliferous, v. calcareous, arg. siltstone to silty ls. - med. gray-green.		
4750											4746.3-4748: dk. gray, lam., pyritic silty mudstone to shale; prop. syngenetic pyrite.		
											4748-4759.1: NODULAR, silty mudstone - very pyrite, bloom-like to amorphous micrite nodules up to at least 1 cm dia. up to 5% pyrite, mostly as nodules, irreg. up to 5 x 3 cm - these closely associated w/ edges of micrite nodules.		
											4759-4765: mudstone/argillite, med. gray, s. pyritic.		
4760											ALSO IN VEINS GREEN MICACEOUS MINERAL ONLY WITH VEIN WHITE		
											* 4765-4769: shattered, brecciated, veined, silicified limestone bone white to v. lt. gray. sparsely diss. clasts & irreg. masses up to 5 mm. dia. of vibrant green micaceous - appearing phase: scattered siltstone in veins; fr. diss. vibrant green sericite (s. fr. deep blue diss. mineral-irreg. clots 2 mm. wide does not appear to be from marker).		
											* @ v. 4769.6 - ZONE OF 1 CM. DIA. XS!! - IN.		
4770											4769-4771: v. dark gray, orange and pyrite-rich argillaceous siltstone to silty mudstone - locally faintly laminated - py. is both disseminated and in concordant thinning & flat lenses - also in irreg. discordant veinlets up to 3 mm. wide - also coarse irreg. clots up to 1/2 mm.		
											4771-4774: As above, except siltier, more fossiliferous - local bands of con. mass. still pyritic, up to 2.5" in thickness.		
											4774-4777.3: laminated mudstone, med.-gray, v.f. as argill. as above, but still quite pyritic.		
4780											4777.3-4783: HIGHLY CONCRETIONARY, LOCALLY MICROFRACTURED & BRECCIATED, SOFT-SED. DEFORMED ARGILLACEOUS, ORG-BEARING & PYRITIC SILTSTONE		
											4783.3-4790.6: SOFT-SED. DEFORMED ARGILLACEOUS Limestone mudstone, siltstone, actually a mega-version of the overlying breccia.		
4790											@ 4790.6 - dip-ups of white grit occurring lower in hole - up to 1/2 cm. wide.		
											4790.6-4793: interbedded calcareous & quartz-gray argillaceous to silty limestone.		
											4793-4799.5: white, bleached-appearing, slightly calcareous massive quartzose grit to coarse-grained sandstone.		
4800											4799.5		

DRILL HOLE VC-12B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS VALLES CALDERA  
 NM

LOGGED BY J. HULEN &  
 J. GARDNER  
 12 DEC. '88





DEPTH	GRAPHIC LOGS														NOTES COMMENTS	DESCRIPTIONS
	ALTERATION					FRACTURING & VEINING	VEIN-FILL	VEINLET FILLINGS				GRAPHIC GEOLOG				
	SERICITE	SILICIFICATION	CHL	CPH	DISS PYRITE			QUARTZ	SERICITE	EPIDOTE	CHLORITE		CALCITE	ANHYDRITE		
4900																4899.5-4900.5: massive, fossiliferous siltstone, stylolitic. 4900.5-4901.1: INTERBEDDED ARGILLACEOUS LIMESTONE & CALCAREOUS CHERT, BOTH FOSSILIFEROUS - locally argillaceous.
4910																4910.1-4915.1: MICRITE, med. gray, thinly bedded, stylolitic (sparse); variably fossiliferous, fusulinid, locally abundant; scattered, undulose, argillaceous partings. 4915.1-4916.1: "BLACK" ORG-RICH, THINLY LAMINATED ARGILL. SILTSTONE. 4916.1-4918.1: LIMY, INTRAFORMATIONAL CSL. 4918.1-4924.2: partially reworked, locally fossiliferous limestone, fine gr. sand grains speckled appearance due to rework.; variably fossiliferous as above. 4924.2-4925.5: NODULAR, ARGILLACEOUS, ORGANIC-RICH, MED. - DK. GRAY LIMESTONE, LOCALLY REWORKED. * Strongly fractured 4925-4924, six both along bedding & at high angles. Calcite & quartz pyrite & chert veins. 60° vertical dip, with in up to 1 cm. some delicately banded.
4920																4925-4924.2: argillaceous, fusulinid-rich, dk. gray limestone 4924.2-4925.5: "BLACK" organic & pyrite-rich mudstone * 4923.8-4924.2: highly irregular, pyromorphic appearing calcite - pyrite - sphalerite veinlet 0.5-4 mm. wide. 4924.2-4925.5: Med. gray muddy siltstone, thinly bedded to laminated. * 4924.2-4925.5: irreg. to elongate pyrite-sphalerite nodules. 4925.5-4926.8: med. gray, arg. to silty limestone, fossiliferous.
4930																4926.8-4928.8: siltstone, arg., faintly plane-bedded, pyrite. 4928.8-4930.2: v. fossiliferous, sl. argill., somewhat disrupted limestone, microfossils present - some filled w/ calcite. Lower 0.15' is org. rich, cut by irreg. py-sp(?) vein up to 13 mm. wide. 4930.2-4932.8: METASILTSTONE, lt. greenish gray, mottled, appearing vaguely bedded; scattered translucent to nearly opaque white to lt. gray porphyroblasts (2-20 μm), commonly rectangular, rimmed w/ white. arg. 2-3 mm. length; abund. chl. in veinlets; silty-textured with, cut by 5 mm. dia. toward base of unit. Below 4932.8-4934.2: resinous-appearing white, metamorphic minerals. 4934.2-4936.8: argillaceous, nematitic METASILTSTONE, blotchy, oxidized/reduced texture - hem. patches rimmed w/ lt. gray gr. RECTANGULAR PORPHYROBLASTS AS ABOVE! 4936.8-4938.8: SAME AS 4932.8-4934.2, diss. ep. below 4934.2.
4940																4938.8-4940.2: METASILTSTONE, lt. greenish-gray med-ds. grnd, gr. rich - minor diss. epidote * UNIT cut by high-angle, partly open gr. veinlets 4940.2-4942.8: silty mudstone, upper 1/2 dark & organic-rich 4942.8-4944.2: AS ABOVE EXC. sl. more silty (consist.) & INTENSE HYDRAULIC FRACTURING/VEINING; LOCAL "jigsaw puzzle" brecciation. 4944.2-4946.8: black organic-rich, locally coaly mudstone - v. pyritic w/ nodules & remobilized pyrite veinlets - intense hydraulic fracturing & veining - most very high (>60°); veins consist of ser., anhy., pyrite & Ar. ep. etc. 4946.8-4948.2: interbedded silty to sandy limestone & calcareous siltstone to sandstone; strong calcite-anhydrite-sulfide veining in hydraulic fractures to
4950																4948.2-4950.2: silty mudstone, upper 1/2 dark & organic-rich 4950.2-4952.8: AS ABOVE EXC. sl. more silty (consist.) & INTENSE HYDRAULIC FRACTURING/VEINING; LOCAL "jigsaw puzzle" brecciation. 4952.8-4954.2: black organic-rich, locally coaly mudstone - v. pyritic w/ nodules & remobilized pyrite veinlets - intense hydraulic fracturing & veining - most very high (>60°); veins consist of ser., anhy., pyrite & Ar. ep. etc. 4954.2-4956.8: interbedded silty to sandy limestone & calcareous siltstone to sandstone; strong calcite-anhydrite-sulfide veining in hydraulic fractures to
4960																4956.8-4958.8: silty mudstone, upper 1/2 dark & organic-rich 4958.8-4960.2: AS ABOVE EXC. sl. more silty (consist.) & INTENSE HYDRAULIC FRACTURING/VEINING; LOCAL "jigsaw puzzle" brecciation. 4960.2-4962.8: black organic-rich, locally coaly mudstone - v. pyritic w/ nodules & remobilized pyrite veinlets - intense hydraulic fracturing & veining - most very high (>60°); veins consist of ser., anhy., pyrite & Ar. ep. etc. 4962.8-4964.2: interbedded silty to sandy limestone & calcareous siltstone to sandstone; strong calcite-anhydrite-sulfide veining in hydraulic fractures to
4970																4964.2-4966.8: silty mudstone, upper 1/2 dark & organic-rich 4966.8-4968.8: AS ABOVE EXC. sl. more silty (consist.) & INTENSE HYDRAULIC FRACTURING/VEINING; LOCAL "jigsaw puzzle" brecciation. 4968.8-4970.2: black organic-rich, locally coaly mudstone - v. pyritic w/ nodules & remobilized pyrite veinlets - intense hydraulic fracturing & veining - most very high (>60°); veins consist of ser., anhy., pyrite & Ar. ep. etc. 4970.2-4972.8: interbedded silty to sandy limestone & calcareous siltstone to sandstone; strong calcite-anhydrite-sulfide veining in hydraulic fractures to
4980																4972.8-4974.8: silty mudstone, upper 1/2 dark & organic-rich 4974.8-4976.8: AS ABOVE EXC. sl. more silty (consist.) & INTENSE HYDRAULIC FRACTURING/VEINING; LOCAL "jigsaw puzzle" brecciation. 4976.8-4978.8: black organic-rich, locally coaly mudstone - v. pyritic w/ nodules & remobilized pyrite veinlets - intense hydraulic fracturing & veining - most very high (>60°); veins consist of ser., anhy., pyrite & Ar. ep. etc. 4978.8-4980.2: interbedded silty to sandy limestone & calcareous siltstone to sandstone; strong calcite-anhydrite-sulfide veining in hydraulic fractures to
4990																4980.2-4982.8: silty mudstone, upper 1/2 dark & organic-rich 4982.8-4984.8: AS ABOVE EXC. sl. more silty (consist.) & INTENSE HYDRAULIC FRACTURING/VEINING; LOCAL "jigsaw puzzle" brecciation. 4984.8-4986.8: black organic-rich, locally coaly mudstone - v. pyritic w/ nodules & remobilized pyrite veinlets - intense hydraulic fracturing & veining - most very high (>60°); veins consist of ser., anhy., pyrite & Ar. ep. etc. 4986.8-4988.8: interbedded silty to sandy limestone & calcareous siltstone to sandstone; strong calcite-anhydrite-sulfide veining in hydraulic fractures to
5000																4988.8-4990.8: silty mudstone, upper 1/2 dark & organic-rich 4990.8-4992.8: AS ABOVE EXC. sl. more silty (consist.) & INTENSE HYDRAULIC FRACTURING/VEINING; LOCAL "jigsaw puzzle" brecciation. 4992.8-4994.8: black organic-rich, locally coaly mudstone - v. pyritic w/ nodules & remobilized pyrite veinlets - intense hydraulic fracturing & veining - most very high (>60°); veins consist of ser., anhy., pyrite & Ar. ep. etc. 4994.8-4996.8: interbedded silty to sandy limestone & calcareous siltstone to sandstone; strong calcite-anhydrite-sulfide veining in hydraulic fractures to

DRILL HOLE VC-7B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 N. MEXICO



LOGGED BY J. HULEN &  
 J. GARDNER  
 12 DEC. 1988



DEPTH	GRAPHIC LOGS											NOTES COMMENTS	DESCRIPTIONS		
	ALTERATION					FRACTURING	VEINING & VLS-FILL.	VEINLET FILLING			FLASKS			GRAPHIC GEOLOGY	
	SER.	EP	CHL	CR	DISP. PYRITE			QUARTZ	SERICITE	EPIDOTE					GALORITE
5100															TO 5108.2': MARBLE, AS ABOVE.
5110													(SAUDIA) "MELANGE" SHEAR CONTACT @ 90°	5108.2-5115': "Melange": highly sheared mixture of limestone, mudstone, siltstone in a foliate altered matrix of calcite (ch. w/ minor epidote); some post-shearing high- $\angle$ microfaulting.	
5120													MONZ. (SHEARED) HIGHLY ALTERED (PE)	5119-5119': sheared, highly altered porphyritic qtz. monzonite, shears, avg 30-40° dip - consist of comminuted rock altered to chl ± ep ± calc(?) phenocrysts up to 2x2 cm (avg. n 2x1.5 cm) now almost totally chloritized; leucokene after sphene & ilmenite.	
5130													SER. PHENOC.	5119-5159': As above, but not as intensely sheared; strong chert, not only of mafics but also of potassium feldspar phenocrysts; increase in intensity of sericitization of plagioclase	
5140													SHEARS DIMINISHES		
5150													F. XLN GRD DIKES		
5160													DIP @ 40°	* 5148.2-5150.1': highly sheared & veined f-med xln. qtz. monzonite dike - especially strong shearing at base - appearance of epidote in veinlets	
5170													CONTACT DIP 60°	5159-5168': APLITE DIKE V. H. slightly greenish to pinkish-grey - sil. grain size 1 mm. faced w/ high- $\angle$ , calcite-dominated veinlets	
5180													APLITE DIKE		
5190													CONT. DIP 70°	5165-5171.8': altered, porphyritic qtz. monzonite as above	
5200													had by 0.5 cm. 89° dip	(epidote increases + replaces mafics & K-feldspar as well as plagioclase)	
5210														* 5178.2-5179.5': K-spar pheros. pink, only slightly altered.	
5220														* Below 5189': K-spar extensively altered to chlorite plus epidote - have mottled to reticulate appearance	
5230													K-SPAR PHEROS HIGHLY ALTERED	* BELOW 5189' - sparse 1-2 cm felsic fine-xln dikeslets dip up to 45° * 5191.8': 2 cm. qtz-calc cemented breccia dipping @ n 90°	

DRILL HOLE VC-2B (FIELD LOG)  
LOCATION SULPHUR SPRINGS, VALLES CALDERA

LOGGED BY HULEN & GARDNER





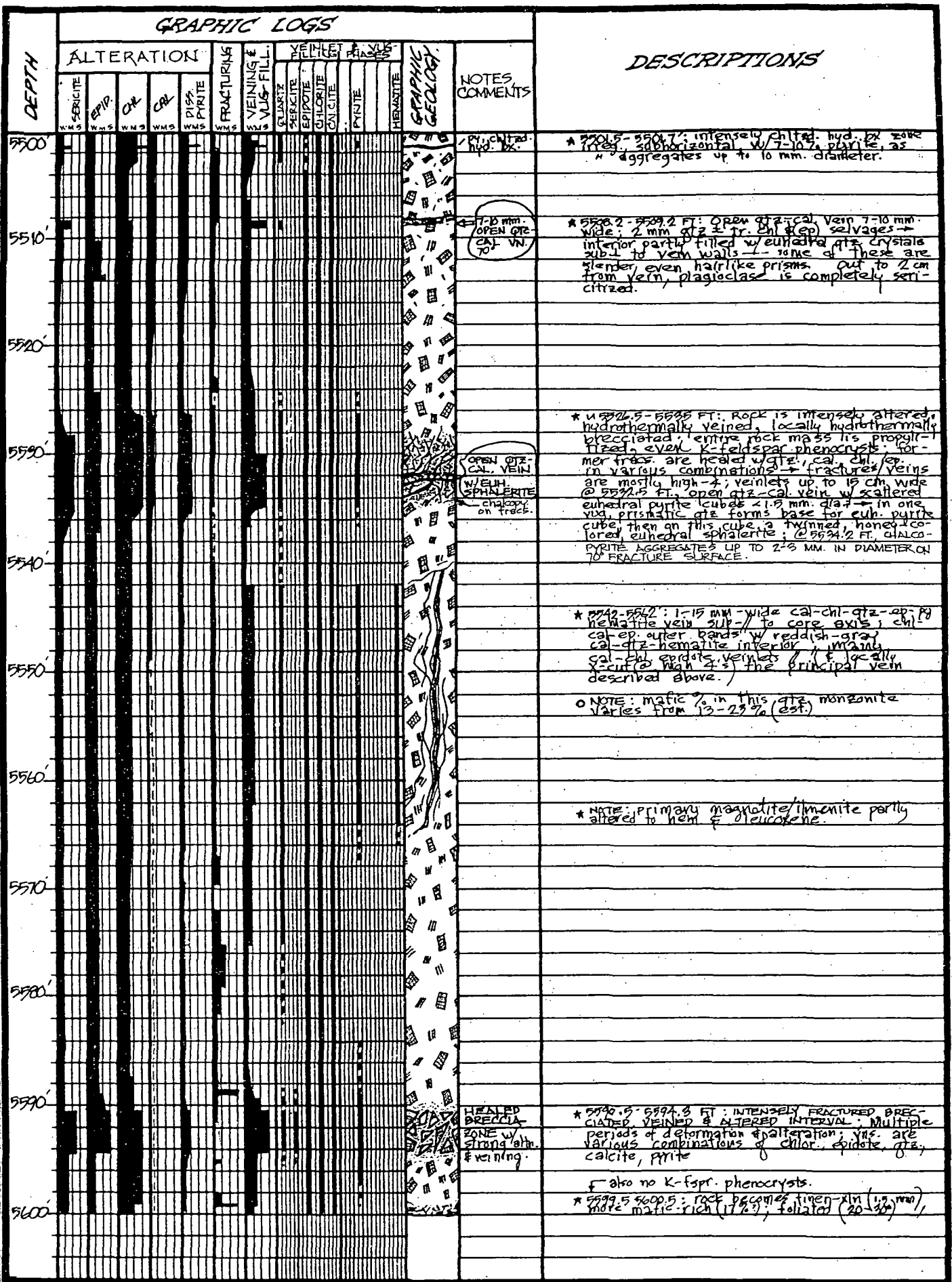
DEPTH	GRAPHIC LOGS													NOTES, COMMENTS	DESCRIPTIONS		
	ALTERATION					FRACTURING	VEINING & VUG-FILL.	VEINLET FILLING			GRAPHIC GEOLOGY						
	PERICLITE	EPID.	CHL.	CAL.	DISS. SPIRITE			QUARTZ	PERCITE	EPIDOTE		CHLORITE	CAN CITE			PYRITE	HEMATITE
5400																	PORPHYRITIC QTZ. MONZONITE CONTINUES.
5410																	"ACTVTRIFF" - JNG- euh. K-feldspar porphyritic quartz monzonite. 20-25% sub- 25 mm.) maximum dimension - commonly stubby bath-shaped; phenos. are embedded in a med- xn. (2 mm), hydric-granular groundmass consisting of qtz, plg, hte magnetite/ilmenite, sphene; 10-12% biotite in clots up to 20 mm. (avg. 1.5 mm) in diameter, hte is variably chloritized; plg variably alt. to sericite & epidote; mag/ilm. partially to completely alt. to leucoxene as is original sphene; veinlets variable intensity, & consist of chl, cal, qtz, ep, in various combi- nations. NOTE: K-fsp. phenos. quite fresh, distinctly pink, translucent.
5420																	so mm. f. gr. gran. dikelet sub-horiz.
5430																	contact 50'
5440																	5431.8 - 5445 FT. Fine-med. xln, sparsely por- phyrific, rel. mafic-rich granodiorite, med. gray- green, variably propylitized. 3-4% sub- h. pink K-fsp phenocrysts avg. 1.5 mm. dia. 15-17% avg. dist. biotite, 1 avg. grain size of rock is about 1.5 mm.; more intensely propylitized below 5435.5.
5450																	5445 - 5454 FT: Pyritic qtz monzonite, as above. * 5448.5' 9x3 cm irregular clot of black tourmaline (?) intergrown w/calcite, leucoxene (CORRESPONDS TO 14" TEMPERATURE INCREASE TO 299°C [COOLED]) POSSIBLE ACTIVE FLUID CHANNEL
5460																	5454 - 5457.2: Fine-xn, pink, mafic-poor (w/3%) biotite granite, selectively hosts rel. abund.; partially open fractures up to 0.7 mm. wide; many of these partly coated w/ chlorite & epidote.
5470																	5457.2 - 5461.5: Porphyritic qtz monzonite, as above. * 5461 - 5472: qtz. monz. is intensely altered, veined → entire rock is med. gray-green, even former K-fsp. phenocrysts (all constitu- ents are chloritized exc. ilmenite/magne- tite & sphene, both of which are converted to lt. buff leucoxene
5480																	TWO 10-15 mm. q-chl-ep- HEN VEIN DIP 85°
5490																	* 5480.7 - 5482.7 FT.: Zone of intense alteration, veining, & hydrothermal brecciation - rock flour breccia veinlets, irreg, up to at least 15 cm. wide. * 5484.7 - 5488.2: rock is extensively laced w/cal- qtz-chl cemented hydrothermal breccia veinlets, shastamosing, up to 3 cm. wide.
5500																	HYDROTHER- MAL BRECCIA

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA,  
 N. MEXICO



LOGGED BY J.B. HULEN





DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CAL-  
 DERA, N.M.



LOGGED BY J.B. HULEN

DEPTH	GRAPHIC LOGS													NOTES COMMENTS	DESCRIPTIONS			
	ALTERATION					FRACTURING	VEINING & VLS-FILL	VEINLET & VLS-PHASES					GRAPHIC GEOLOGY					
	SERICITE	EPID.	CHLOR.	CALCITE	HYD.			PYRITE	QUARTZ	SERICITE	EPIDOTE	CHLORITE				CALCITE	PYRITE	HEMATITE
5600																	* to 5605.0 FT. Dike has a bluish-green cast; K-spar porphyroclasts are partially chloritized; banded cal-chl-hem. veinlets present.	
5610																		
5620																		
5630																		
5640																		* @ 5643.0 FT.: 0.1 FT wide shear zone, intensely chloritized.
5650																		5641.5-5648.0 FT.: FINE-GRAINED, MAFIC-POOR GRANITE, SAME AS 5634-5637.2 FT.; BELOW 5645' → ROCK IS STOCKWORK FRACTURED, LACED W/CAL-EP & CHL. VEINLETS
5660																		5648.0-5750': PORPHYRITIC QTZ MONZONITE, AS ABOVE.
5670																		* 5650.5-5650.8': Fine-med. gr. mafic-rich gneiss(?) xenolithic, v. ragged edges
5680																		* 5653.0-5653.6 FT.: pink, red-Xln. leucocratic granite dike
5690																		* 5655.0-5655.7 FT.: 10-15 CM. CAL-QTZ-EP. VEIN; QTZ-EP. SELVAGE, CAL. INTERIOR.
5700																		* 5660.9-5662': INTENSELY FRACTURED & ALTERED ZONE W/CAL-QTZ & CAL-QTZ-EPIDOTE VEINLETS UP TO 7mm. wide; ep.-bearing veinlets locally open, w/vugs up to 15x7 mm, containing chlorite rosettes & calcite xls. up to 3 mm. diameter. 6-30 angular epidote microcrystals.
5710																		
5720																		
5730																		* 5679.2': QTZ-CHL-CAL-PY VN 2mm. wide, dip 75° PARAGENESIS IS QTZ, CHL+CAL+PY
5740																		
5750																		* 5694.5-5696': hydroth. bx. dike, med.-dk. gray-green; chilled, rock flour + bx interior 1-26-30 mm. wide 2 selvages; + 1-3 mm qtz-hem, 1-3 mm. cal-epidote.

DRILL HOLE VC-28 (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA

LOGGED BY J. B. HULEN  
 J. N. GARDNER



GRAPHIC LOGS

DEPTH	ALTERATION														GRAPHIC GEOLOGY	NOTES COMMENTS	DESCRIPTIONS				
	SER		EP		CH		CA		DISS PYRITE		FRACTURING		VEINING & VUG-FILL					VEINLET FILLING		FRASSES	
	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS	WMS				WMS	WMS	WMS	WMS
5700'																				gta - CAL V.	* 5704-5708: massive gta-cal vein, 70'-90' dip, up to 13 mm wide, thin microbxs silicate, minor gem chrt, fr purple calcite, increasing increase in pale altn. intensity.
5710'																					
5720'																					* 5725-5731: melanog badolite xenolith(?) strongly epidotized - altn. more intense at margins.
5730'																					* 5730-5734.5: intense hydrothermal veining and alteration. veins are dominantly high- $\alpha$ & of multiple ages; early calcite + hematite, later calcite-chlorite, quartz; veinlets appear to be developed in high- $\alpha$ tectonic fracture zone.
5740'																					
5750'																				OPEN EPIDOTE CALITE VUGS. POSSIBLE ACTIVE FLUID CHANNELS OPEN EP-CAL VEIN-LETS	* 5750-5751.2: Intensely veined, mod altered; veinlets are randomly oriented but many are high- $\alpha$ ; veinlets dominated by epidote, as acicular xls, growing from veinlet walls; also minor gta, minor rhombohedral calcite xls up to at least 1-2 mm in dia. calcite is apparently early; ep xls gen < 1.5 mm in length and are very hair-like. + also: growing at the tips of some ep xls & coating some calcites are 2-0.5 mm globular masses of an unknown pearlescent mineral, because of the common open spaces in these veinlets, this zone is a good candidate as an active thermal fluid channel.
5760'																					
5770'																				HYDROTHERMAL VEINLETS	* 5756-5758.3: As above except apparently lacking the pearlescent late-stage mineral; even more open space, perhaps an even more likely fluid channel.
5780'																					

DRILL HOLE VC-2B (FIELD LOG)  
 LOCATION SULPHUR SPRINGS, VALLES CALDERA  
 NM -81-

LOGGED BY J. HULEN & J. GARDNER  
 01/12/88

### SAMPLE ACQUISITION

Core from VC-2B (as well as VC-1 and VC-2A, previously drilled Valles CSDP coreholes) is ready for sampling at the Dept. of Energy's Core and Sample Repository in Grand Junction, Colorado. Those wishing to obtain core samples can either do so in person or submit requests to the Repository's curator. A companion volume to this log, written by Virginia Starquist of LANL and containing detailed curatorial information, will shortly be available and should facilitate sample requests. These should be directed to:

Richard Dayvault, Curator  
DOE Core and Sample Repository  
UNC Geotech  
P.O. Box 1400  
Grand Junction, CO 81502  
(303)-242-8621

A copy of each request should be sent to Jamie Gardner at LANL (address in Appendix 2).

### ACKNOWLEDGEMENTS

The VC-2B project was sponsored by the U.S. Department of Energy's Office of Basic Energy Sciences. Meticulous observations by drill-site scientists Bill Crisswell, Rob Gribble, Kim Meeker, John Musgrave, Tim Smith, and Dan Wilson were essential in preparing this log. Thom Little and Peggy Snow identified many of the metallic and other vein minerals using the scanning electron microscope. Kim Meeker and Fraser Goff employed the petrographic microscope and electron microprobe to investigate deep

recrystallization and hydrothermal alteration in the Sandia Formation. VC-2B site operations were supervised by Pete Lysne, Ron Jacobson, and Allan Sattler of the GRDO. The actual drilling was smoothly completed by Tonto Drilling Services under the direction of Larry Pisto, Ron Fireback, Mike LaOrange, Bill Cunningham and Jerry Gillespie.

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APPENDIX 1  
ABBREVIATIONS

AB--albite	DEF--definitely
ABUND--abundant	DEFM--deformation
ACC--accessory	DEP--deposited
ACCR--accretionary	DIA--diameter
ACCRET--accretionary	DISS--disseminated
AF--ash-flow	DK--dark
AFT--ash-flow tuff	DOL--dolomite, dolomitic
AGG--aggregate	DOM--dominated,
ALT--altered	dominantly
ALTN--alteration	DW--densely welded
AND--andesite	
ANH--anhydrite (rarely	E G.--for example
"anhedral")	EP--epidote
ANHYD--anhydrite	ESP--especially
APP--apparently	EUH--euohedral
ARG--argillaceous	EXC--except
ARGILL--argillaceous	
BEC--becoming	F--fine
BIPYR--bipyramidal	FL--fluorite
BN--bornite	FLD--fluid
BRACH--brachiopod	FLUOR--fluorite
BX--breccia	FLT--fault
BXTN--brecciation	FM--formation
	FOL--foliation
CAL--calcite	FOL'N--foliation
CALC--calcite, calcareous	FRAC--fracture(s)
CALCAR--calcareous	FRACT--fracture(s)
CARB--carbonate	FRAG--fragment
CH--chlorite	FRX--fractures,
CHALCED--chalcedony	fracturing
CHALCOPY--chalcopyrite	FSP--feldspar
CHL--chlorite	FT--feet
CHLTZD--chloritized	FXLN--fine-crystalline
CHLTZN--chloritization	
CM--centimetres(s)	G--grained
COMP--compaction (rarely	GR--grained
"composition")	GRN--green
COMPAC--compaction	
COMP FOL--compaction foliation	
CONT--contact	HEM--hematite
CPY--chalcopyrite	HORIZ--horizontal
CRS--coarse	HYD--hydrothermal
CRSR--coarser	HYDROTH--hydrothermal
	HYDROVOLC--hydrovolcanic

IG--ignimbrite	PREDOM--predominantly
IL--illite	PROB--probable, probably
ILM--ilmenite	PROM--prominent,
INC--inclusion(s)	prominently
INCR--increase, increasing	PTLY--partly
INTBDED--interbedded	PY--pyrite
INTM--intermediate	
INTRAFM--intraformational	
IRREG--irregular	Q--quartz
	QTZ--quartz
K--potassium	
KF--potassium feldspar	REL--relatively
KFSP--potassium feldspar	RH--rhodochrosite
K-SPAR--potassium feldspar	RHODOCHR--rhodochrosite
	RHY--rhyolite
LAM--laminated	RND--round(ed)
LAP--lapilli	RX--rock(s)
LEUC--leucoxene	
LG--large	S--strong
LIMEST--limestone	SCATT--scattered
LS--limestone	SEC--section
LST--least	SED--sediment
LT--light	SEP--separated
	SEQ--sequence
M--metre(s) (rarely "medium")	SER--sericite
MAG--magnetite	SEV--several
MAX--maximum	SILIC--silicification
MED--medium	SILTST--siltstone
MICROXLN--microcrystalline	SL--slightly
MINRL--mineral	SLIX--slickensides
MM-millimetre(s)	SLTST--siltstone
MO--molybdenite	SOLN, SOL'N--solution
MOD--moderate, moderately	SP--sphalerite
MOLYBD--molybdenite	SPH--sphalerite
MOS <sub>2</sub> --molybdenite	SPHAL--sphalerite
MONZ--monzonite	SPHALER--sphalerite
	SS--sandstone
NOD--nodule	STKWK--stockwork
NW--non-welded	SUBH--subhedral
	SURF--surface
PH--phengite	
PHENG--phengite	TEMP--temperature
PHENO--phenocryst	TL--total
PL--plagioclase	TR--trace
PLAG--plagioclase	TRANSL--translucent
PORPYROB--porphyroblast	
POSS--possibly	
PPY--porphyry	
PPYTIC--porphyritic	
PR--primary	

V--very  
VAP--vapor  
VN--vein  
VNLT--veinlet  
VOLC--volcanic

W/--with  
WO/--without  
WK--weak  
WKLY--weakly  
WT--weight

X--cross  
XL--crystal  
XLINE--crystalline  
XLN--crystalline  
XTAL--crystal

#### SYMBOLS

‡ --and  
∩ --about  
∠ --angular  
= --equal to  
> --greater than  
< --less than  
≤ --less than or equal to  
μ --micro-  
// --parallel  
⊥ --perpendicular  
2<sup>nd</sup> --secondary  
‡ --with or without

APPENDIX 2

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