GL01539

1. GEO Operator Corp (GEOOC) - Subsidiary of
Geothermal Resources International
545 Middlefield Rd Suite 200
Menlo Park CA 94025
415-321-5662

To be drilled by Geo Newberry Crater, Inc.
Swanberg is President GNC
" " Vice President GEOOC

2. Team GNC
Mike Johnson - US Geologist, fresh
Jeff Haizlip - Geochemistry MA
Mike Cole - Environment

3. Location: 3500'W, 2450'N SE cor Sec 25, T22S R12E
Deschutes Co, Oregon: elev 5-8500'
S. flank Newberry volcano

4. Newberry one of few volcanoes ~~under~~ not restricted by parks or wilderness
- no surface manifest in area core hole
- Hg - soil anomalies S & SE of caldera and along N rim.
- both basaltic & silicic magmatism
- Brothers FZ - silicic magmatism gets younger NW, is 1350 BP at Newberry volcano.
- similar mineralogy & chemistry of domes suggest underlying magma
- USGS hole in caldera to 3058' got 509°F, all in Cenozoic volcanics
- volcano marked by 16 mgal residual gravity high centered over western boundary of volcano - Gene C. postulates due to magma
- 1000 ft + residual over caldera -- maybe mag reflects ring dikes
- holes in Caldera include USGS-1, USGS-2, Sandia RDO-1
- RDO-1 isothermal at 40°C (actually slightly reversed) to 280 m, then straight graded to 160°C at 340 m

5. Proposal says:
- 2000' rain certain in Caldera
- 2500' to commercial temps outside caldera
- no reservoir rocks identified yet. Cited valles experience of being unable to locate "reservoir rocks"
- Area is good because:
geologically young: intersection of Cascades range & Brothers FZ: caldera @ intersection of NE & NW fractures
geophysics suggests shallow magma: hot springs & drill results in caldera: Hg anomalies

- USGS-2 deduit penetrate cap rock, i.e. gradient conductive to TD.

6. Penetration of regional g.w. table expected @ 2400!

7. Elements SOW
   1. Drilling
      - Surface and Subsurface conditions
      - Site access
      - Site Prep
      - Hole Design
      - Anticipated Problems
      - Drilling Fluids & Disposal Method
      - Hole Completion
      - Plugging and Abandonment
      - Site Restoration
      - Rig & Equipment Spec's
      - Mud containment
      - Site Facilities
      - Health, Safety and Environmental Considerations
        - health & Safety - BOP, H_2S
        - Environmental: Air Quality; Noise; water quality; water supply; Land disturbance; Subsidence & Seismicity; Ecology; Socioeconomics; Heritage resources; visual; Site reclamation
      - Drilling Schedule
   2. Data collection
      - Types
        - during drilling
        - after drilling
      - Depths
      - Timing
      - Method
      - Additional Data
      - Formation Fluids
      - Drill Stem test
      - Reservoir Engineering
   3. Hole completion & Maintenance
   4. Abandonment

8. Business Approach
   1. Relevant Experience
      - prev. gvt contracts
   2. Proj Manag Plan etc.

1. GEOOC

4100'N, 500'E SW cor Sec 24 T 20S R12E
Deschutes Co, Oreg. Elev 6000 ft MSL

2. Lies outside gravity anomaly.

3. Rig Specs

C.P. 50 Hydrostatic Diamond Core Drill

Thermal Power

1. Between Western Cascades and High Cascades
   - ~~heat source~~ NW1/4 SE1/4 Sec 28 T8S R8E Marion Co, Oregon -- Clackamas area
   - heat source postulated to underlie Olallie Butte
   - erupted lavas appear to become more siliceous in time. Plateau constructed in last 2000 yrs, w/ some ash of plateau overlying Mt. Mazama ash of 6900 years old.
   - Shallow magma chamber indicated on basis of petrochemistry. Deep, large chamber indicated by Blackwell et al 1982
   - no surface manifestations

2. TMT survey totalling 144 stations done for Chevron, who gave data to TP, conducted by Terraphysics for Chev in 1981 (Sept). ? ← Yungul says 77 → 22 MT → 55 T
   State TMT much cheaper than MT. Interp by Yungal, SH. in 1981, using 1D Bostick + some 2D. Shows resistivity lows to 4 Ω-m in a zone between 3000-9000 feet w/ 2-D modeling. At Breitenbush limited TMT survey indicated low-ρ zone 1000-3500 feet and a "geoth aquifer was encountered at ≈ 3500'" in the Sunedco deep well.

3. Sunedco well to 8060 feet

Profile	elev (ft)	~~temp~~ °F (±5°) graph reading	
collar	2900	68	
	2650	60	
	450	280	- George says 136°C
	-2600	285	- George says 141°C but projects to 159°C equilibrium gradient.

4. Petrochemical trend

age	rock type
early Pleisto	olivine - phyric basaltic andesite
middle Pleisto	more siliceous basaltic andesite
late Pleisto	B.A to dacite

136°C
141°C TD – not asfable temp.
proj bht = 160°C

5. George says – Sunedco drill hole @ Breitenbush to 8030' ~~was~~ cost about $3M. Due mainly to cost of surface preparation -- drilled above a drinking watershed, hard to construct big mud pit-

George says EWEB-6 gives 100 mWm⁻² heat flow.

George says Al Weidle is a competent geol -- did lots more temp gradient work not reported in TP proposal

6. Soil Hg survey shows anomalies
   - over Austin HS NW trend w/ zone > 2000 ppb
   - Breitenbush HS 100-500 ppb
   - sec 5, 6, 7, 8 T 9 S R 8E - west of Olallie Butte
   - sec 1, 2, 11, 12, 13, 14 T 8 S R 7E
   - sec 2, 11, S½12, 13, E½14 T 7 S R 7E

   They relate anomalies to structures w/ N-S trends and NW trends

7. Conceptual model
   - Olallie Butte is interp to be a growing stratovolcano w/ shallow magma chamber.
   - Rain/snow @ Olallie Butte along crest Cascades infiltrates, sinks, is heated, rises along structures, flows updip (gentle E dip to beds west of crest of High Cascades) to come out at Austin & Breitenbush. Permeable horizons are Sardine and Breitenbush fms. Springs are in deep stream valleys

8. Hole sited: near structural intersection NS w/ NW-trending faults close to stratovolcano Olallie Butte, within TMT resistivity low. No Hg anomaly.

9. George says "whole Oligocene is altered to clays and is probable source of TMT" -- TMT may not be related to thermal waters..

10. Thermal Power
   - established 1956 through efforts of Magma Power Co
   - Thermal-Magma put in initial unit at The Geysers
   - 1967 Union + Thermal-Magma formed new jt venture
   - now its Union – Thermal, who jointly own 120 steam wells w/ 984 MW capacity
   - 1974 Natomas acquired Thermal
   - 1983 Diamond Shamrock acquired Natomas
   - present size = 34 employees.

11. Work Schedule

Months	Milestone Complete
0	Execute Coop Agreement
4	Approvals for Plans, Permits
7	Contracts for drilling, logging
11	Drilling Completed
23	DOE access period closed.
24	Terminate Coop Agree

12. Drillers to be considered
Tonto, Longyear, Jannsen (Preston)
Loggers to be considered
BPB Instruments, Inc
Colorado Well Logging, Inc
Georand
Southwest Surveys

13. Plan of Operation - submitted to BLM Area Geothermal Supervisor as per Title 43, Chapter II, Section 3262.4 with no EA, process of approval takes ≅ 30 days
Forest Service has monitoring authority
- Site Specific Environ Eval Rept CEERS is a DOE requirement, DOE guidelines.

14. - Western Cascades - Tert volcanic arc
- oldest High Cascades form low-relief platform, composed of olv-basalts and basaltic andesites, are early Pleistocene 10_2 my.
- Modern High Cascades

DLN 15. Olallie Butte area is interesting. Small andesite and dacite flows and domes, lapilli tuffs occur to South and west. Suggestive of differentiation, maybe high-level silicic magma chambers or areas of partial melt. Sisi & Pinhead buttes are more mafic basalt and andesite-basalt cones. Dacite = Campbell Butte, Agrarian Butte, Double Peaks

16. See White, 1980 DOGAMI sp paper 9 for dates

17. Near Olallie Butte some flows earlier than Mazama ash @ 6900 BP.

18 summary geol Clackamas –

- Quat cascades volcs of High Cascades underlain by complex Tert volcs.
- Quat 0–1500' thick
- Beneath are pliocene basalts Outerson fm pyroclastics of miocene Elk Lake & Outerson together 2000–3000' thick
- Then mid-miocene of Sardine and Nohorn and mid Oligocene pyroclastics of Breitenbush extensively fract'd & alt'd –
  - -- These are reservoir rocks –

12. Send for "Laws and Adm. Rules relating to Geoth expl & develop in Oregon" Misc pap # 8, part 2, 1981