BREITENBUSH GEOTHERMAL PROSPECT

LITHOLOGY

for Drill Hole

U.S.A 58-28

Sunoco Energy Development Co.

Breitenbush

Marion Co., Oregon

Waibel
Geol. Services

Basalt: gray to dark, olivine and plagioclase microporphyritic basalt with some micro-vesicles partially to completely filled with dark green clay or chlorite. Local zones of shearing are present with clay and serpentine alteration. Secondary very fine grained pyrite occurs throughout in trace quantities, but increased concentrations of pyrite are found in some of the sheared zones.

No distinct flow boundries are observed in this unit suggesting that it is a single massive unit (subvolcanic intrusive?) rather than a composite of flows.

T.S.→

Tuffaceous Sediments: dark gray to gray, minor brown gray, locally fissile, lithic-rich tuffaceous sediments. Lithic clasts are predominantly basaltic lava less than 1mm across. Very fine grained pyrite is common.

Basalt: dark gray, olivine and plagioclase porphyritic basalt. Minor amounts of dark green amygdules of clay or chlorite are found as well as abundant secondary pyrite.

Tuffs and Tuffaceous Sediments: gray to dark gray to brown gray, intercalated crystal and lithic-rich tuffs and tuffaceous sediments. Local zones of carbonaceous material are found. Secondary hematite and pyrite are observed in local concentrations.

Basalt: dark gray, olivine and plagioclase porphyritic basalt.

Tuffs and Tuffaceous Sediments: gray to dark gray interbedded tuffs and crystal and lithic rich tuffaceous sediments. Local zones in these tuffs show increased concentrations of carbonaceous material. Locally the tuffs are fissile. Minor to trace amounts of secondary pyrite occur in local concentrations.

Basalt: dark gray, pyroxene and plagioclase porphyritic basalt.

Tuffaceous Sediments: gray to brown, slightly carbonaceous, montmorillonite rich fine grained tuffaceous sediments. Minor secondary pyrite is found.

TS→

Welded Tuff: gray to dark gray welded tuff with localized concentrations of ash size fragments of plagioclase, glass, and possibly olivine.

Tuffaceous Sediments: brown to gray to light gray, montmorillonite rich, fine grained tuffaceous sediments. Local concentrations of carbonaceous material associated with lesser amounts of pyrite are found.

Tuffaceous Sediments: light gray to brown gray to brown, fine grained, montmorillonite rich tuffaceous sediments, with minor interbeds of crystal and lithic rich tuffaceous sediments.

Basalt: dark gray, olivine and plagioclase porphyritic basalt with occasional vesicles lined with dark green clay. The dark gray groundmass is slightly altered to clay and/or possibly chlorite. Trace quantities of calcite and unidentified zeolite occur along small fractures.

Tuffaceous Sediments: brown to brown gray, medium to fine grained, crystal and lithic rich tuffaceous sediments, with minor carbonaceous zones. Montmorillonite alteration is common.

Welded to Cemented Tuffs: gray to green gray to brown gray, quartz and hornblende bearing, locally eutaxitic, lithic-vitric tuff. The tuff shows gradational change from a cemented to a welded tuff. The greenish color of the tuff is considered a result of secondary celadonite and chlorite.

T.S.→

T.S.→ Fresh cpx + opx phenos Qz is rare →

Welded to Cemented Tuffs: gray to green gray, locally brown gray, crystal bearing lithic-vitric tuff. The tuff is predominantly cemented with minor welded horizons locally displaying eutaxitic textures. The crystal content consists mainly of clear feldspar fragments with minor angular quartz fragments. Lithic clasts vary from basaltic to silicic rock fragments. Secondary celadonite and chlorite occurs locally.

T.S.→ Analyze

Andesite: dark green gray, microporphyritic andesite with femic phenocryst minerals considered to be pyroxene. The groundmass and femic phenocrysts are altered to chlorite and hematite. Secondary chlorite and antigorite occurs along fracture planes. Trace amounts of pyrite occurs in the andesite.

Welded to Highly Cemented Tuffs: light green gray crystal bearing, lithic-vitric cemented tuff. Crystal fragments are predominantly subangular to subrounded clear feldspar, usually less than 1mm across. Lithic clasts are strongly clay altered volcanic clasts up tp 4mm across.

T.S.→

Welded to Highly Cemented Tuffs: Green gray to gray to purple gray, cemented with zones of eutaxitic welded crystal-vitric tuff. Crystals consist mainly of angular feldspar fragments which are usually clear with occasional black opaque inclusions. Greenish color of the tuff is the result of celadonite alteration.

T.S.→

Andesite: dark gray, strongly clay altered, locally vesicular, plagioclase porphyritic andesite. Many of the vesicles are filled with a dark green clay.

T.S.→ analyze

Cemented to Welded tuff: dark gray to dark green gray cemented, crystal bearing lithic-vitric tuffs. Local zones show developed eutaxitic texture indicative of welded horizons. Crystals are angular to subrounded clear feldspar less than 1mm across, and minor amounts of a black unidentified mineral. Lithic clasts of various volcanic rock types are strongly altered, and compose up to 80% by volume of the rock.

T.S.→

Welded Tuff: green gray, eutaxitic, crystal bearing lithic-vitric tuff. Eutaxitic pumice are more common at this level. Quartz and feldspar are the commonly observed minerasl, and show embayed textures. Lithic clasts of volcanic rock are dominantly silicic.

Trace to minor amounts of mylonite observed.

Trace to minor amounts of mylonite observed.

Welded Tuff: green gray, eutaxitic, pumaceous, crystal bearing vitric-lithic and lithic-vitric welded tuff. A minor amount of the pumice is devitrified with much celadonite alteration. Clean crystals of quartz and feldspar, composing from 2 to 8% by volume of the tuff, show embayed textures. Lithic clasts of varied volcanic rocks, up to 5mm across, compose between 20 and 70% by volume of the tuff.

T.S.→ Sl. embayed Qz ½%
2,470

2,470' = 136°C MRT reading

T.S. → no qtz
2,566

Cemented to Welded Tuff: orange brown to greenish gray cemented to welded crystal bearing lithic-vitric tuff. Clear angular feldspar crystals are present. Lithic clasts of varied volcanic rocks compose up to 20% of the tuff by volume. Minor amounts of veins are present with laumontite and traces of calcite mineralization.

2,566' = end of aquifer on Blackwell's T-log

~~2500-2640 ft.: Shear zone with trace to minor amounts of mylonite.~~

Cemented to Welded Tuff: as above with local zones of silicification and veins of quartz, minor laumontite, and trace calcite.

Cemented to Welded Tuff: as above with secondary minerals including silica, clay, laumontite, minor calcite, hematite, and trace pyrite.

2810' 856 m.

T.S.→

Andesite: light greenish gray, recrystallized hornblende and plagioclase porphyritic andesite. Hornblende phenocrysts make up to 2% by volume of the rock and usually show reaction rims. Plagioclase phenocrysts compose less than 1% by volume of the rock, and display light yellow green alteration. Secondary minerals occur as vein filling and includes laumontite, possibly K-feldspar, and very minor calcite.

analyze

3050' 930 m

Tuff: light brown to light green, devitrified, crystal bearing lithic-vitric tuff. Lithic fragments are usually angular to subrounded and darker than the surrounding matrix. Crystals of white to clear feldspar are partially altered. Quartz fragments are also present. Secondary minerals include clay, silica, laumontite, possibly heulandite, hematite, and trace pyrite.

T.S.→
3070-3100' has same Qz as Qz-Tb

Tuff: light green gray to green gray, eutaxitic, metasomatized, crystal bearing lithic-vitric tuff. Crystals include subrounded quartz with embayments, subhedral to euhedral cloudy feldspar, and subhedral to euhedral specular hematite. Occasionally quartz crystals contain black opaque inclusions. Lithic clasts of varied volcanic rocks compose less than 15% by volume of the tuff. Secondary vein minerals include laumontite, heulandite, quartz, possibly K feldspar, and illite. Mylonitized tuff fragments occur in trace quantities throughout.

Tuff: dark brown gray to green gray to dark gray, locally silicified, crystal bearing lithic-vitric tuff. Secondary vein minerals include laumonitite,heulandite, quartz, possibly K feldspar, and illite.

Andesite: dark green gray, clay and chlorite altered, plagioclase and hornblende porphyritic andesite.

Tuff: dark brown gray to dark green gray, locally strongly silicified, crystal bearing, lithic-vitric tuff. Fragments of angular quartz and metasomatically altered feldspar make up less than 2% by volume of the tuff. Lithic clasts of varied volcanic rocks make up to 20% by volume of the tuff. Secondary minerals include laumontite and K feldspar as vein fillings, and minor chlorite.

3490-3615 ft.: Minor mylonite present throughout. This shear zone is considered to contain fluid.

Intercalated Andesites and Tuffs: this zone contains intercalated volcanic or subvolcanic andesite and metasomatized tuff. The andesite is dark green gray to gray, chloritized and clay altered, plagioclase, hornblende, and augite porphyritic andesite with minor secondary laumontite and trace pyrite. The tuffs are white to light gray metasomatized, eutaxitic, crystal bearing lithic-vitric tuffs. The phenocrysts include quartz, altered feldspar, and an unidentified altered femic mineral. Secondary minerals include clay, silica, calcite, and localized areas of chlorite.

Tuff: brown to green gray, devitrified, cemented, crystal bearing lithic-vitric to vitric-lithic tuff. Angular to subrounded ash size mafic lithic clasts compose up to 50% by volume of the tuff. Secondary vein minerals include laumontite, massive calcite, occasional druzy quartz, and small pods of chlorite.

Tuff: as above with increasing mineralization.

Basalt: dark gray to dark green gray, chloritized, locally albitized, porphyritic, metamorphosed basalt. Vein minerals compose up to 50% by volume of the basalt, and include laumontite, other unidentified zeolites, chlorite, minor calcite, and trace pyrite.

T.S.→

Tuff: brown gray to green gray, devitrified, cemented, lithic-vitric tuff. Angular to subrounded ash size mafic lithic clasts compose up to 20% by volume of this tuff. A minor crystal component of the tuff consists of altered feldspar and trace specular hematite. Secondary minerals occurring in veins include laumontite, occasionally associated with chlorite.

Tuff: as above, with secondary minerals includeng vein laumontite, calcite, and chlorite. Non-vein minerals include laumontite, quartz, illite, albite, chlorite, hematite, pyrite, and calcite. Occasional mylonite fragments are found throughout.

Tuff: as above, with local zones of silicification, and increased vein laumontite and quartz.

Tuff: brown gray to gray to green gray, strongly altered to clay, crystal bearing lithic-vitric tuff. Angular to subrounded lithic clasts are of varied volcanic rocks. The minor crystal component consists of altered feldspar and magnetite. Secondary minerals include vein filling laumontite, calcite, chlorite, and pyrite. Secondary non-vein minerals include clay, calcite, laumontite, minor chlorite, trace pyrite, and trace epidote.

Mafic Intrusive: Dark gray to green gray, holocrystalline, augite and plagioclase porphyritic basaltic subvolcanic intrusive. The groundmass displays clay and chlorite alteration with minor amounts of zeolite, magnetite, and pyrite. Clear plagioclase phenocrysts up to 1mm long, with opaque inclusions, make up to 20% by volume. A minor amount of subhedral to anhedral clear brown augite occurs as a phenocryst phase. Secondary minerals, predominantly vein filling, include laumontite, silica, calcite, minor chlorite, and pyrite.

T.S.→

Minor Shearing.

Welded to Cemented Tuffs: green gray to dark orange gray, devitrified, locally metasomatized, crystal bearing lithic-vitric to vitric-lithic tuff. The crystal content consists mainly of cloudy albitized feldspar and minor euhedral magnetite. Lithic clasts of varied volcanics compose up to 70% by volume of the tuff. The tuff has been strongly zeolitized. Secondary minerals include laumontite, clay, and minor calcite. Local zones of clay and chlorite alteration occur in association with silicification and secondary pyrite.

T.S.→

Welded to Cemented Tuff: as above, with occasional silica and pyrite veins accompanying minor green gray clay and chlorite alteration zones.

Welded to Cemented Tuffs: dark gray to dark orange gray, devitrified, locally eutaxitic, crystal bearing lithic-vitric tuff. A minor crystal component consists of clear to cloudy feldspar fragments and lesser amounts of euhedral magnetite. Lithic clasts of mafic to intermediate volcanics make up from 5 to 15% by volume of the tuff. Secondary Disseminated minerals include clay, laumontite, minor calcite, local zones of hydrous Fe-oxides, trace silica, and trace chlorite. Secondary vein minerals include silica, laumontite, calcite, chlorite, and pyrite.

T.S.→

Welded to Cemented Tuff: as above, with secondary laumontite, clay, calcite, and minor chlorite.

Mafic Intrusive: light gray to light green gray, holocrystalline, plagioclase, augite, and hornblende porphyritic, basaltic/andesitic subvolcanic intrusive. The groundmass is predominantly plagioclase, green clay, minor calcite, and fine disseminated magnetite. The phenocryst phases show various degrees of alteration. Secondary minerals occur mainly as vein filling, and include laumontite, minor calcite, and clay.

T.S.→

Mafic Intrusive: as above, with localized zones of silicification; secondary disseminated clay, chlorite, magnetite, and calcite; and secondary vein filling calcite, silica, laumontite, and pyrite.

Welded to Cemented Tuff: brown to red brown, locally eutaxitic, crystal bearing and lithic bearing vitric tuff. Crystals include angular to subrounded quartz, sanidine, and traces of magnetite. Lithic clasts are a variety of volcanic rock fragments. Secondary minerals include clay, trace hematite, and trace laumontite.

Fault: with no associated mineralization.

Welded to cemented Tuffs: as above, with secondary mineralization limited to clay and trace laumontite.

Fault: with no associated mineralization.

T.S.→

Mafic Intrusive: green gray to dark green gray, holocrystalline, chloritized hornblende porphyritic diorite. The hornblende phenocrysts are very altered crystal remnants occurring in trace amounts. Secondary minerals include local silica metasomatization, clay, disseminated magnetite, calcite, minor laumontite, and trace pyrite.

Welded to Cemented Tuff: mixed zones of gray brown to red brown altered crystal and lithic bearing vitric tuff; and light green, strongly metasomatized and locally hornfelsic tuff. Relict clastic texture indicates that this is a single unit that has undergone a variety of local alterations. Common alteration minerals include silica, albite, calcite, illite, minor chlorite, and Fe-oxides. Vein minerals include calcite, laumontite, and minor chlorite. Minor amounts of mylonitized tuff occur throughout.

Welded to Cemented Tuff: as above, with an increase in cryptocrystalline silica in veins, and a corresponding decrease in laumontite.

Welded to Cemented Tuff: continuing zones of brown crystal and lithic bearing vitric tuff, and light green metasomatized tuff. Secondary minerals similar to above, with the addition of drusy quartz, decreasing amounts of calcite, and trace amounts of pyrite.

Minor amounts of mylonite present.

Increase in pyrite, as very small sphyrical aggregates.

T.S.→

Welded to Cemented Tuff: white to green white to brown white hornfelsic tuff, totally recrystallized to a fine grained aggregate of silica, albite, illite, and minor chlorite. Pyrite, often showing surface oxidation, occurs in trace amounts. Other secondary minerals include Fe-oxide staining throughout, and vein silica, quartz, minor chlorite, minor calcite, and trace laumontite. Mylonitized tuff fragments are common.

T.S.→

Mafic Intrusive: gray to green gray, chloritized hornblende porphyritic basaltic/andesitic subvolcanic intrusive. Most femic minerals have been altered to chlorite. Minor anhedral quartz occurs, apparently as a primary mineral. Fractures are common, and vein minerals include calcite, chlorite, and minor laumontite.

Hornfelsic Lithic Tuff: white to light green white to yellow white hornfelsic quartz bearing lithic tuff. Minor relict texture survives, including ghost outlines of lithic clasts. Quartz crystals are the only remaining primary mineral. Secondary minerals include silica, quartz, albite, illite, calcite, chlorite, trace laumontite, pyrite, hematite, and specular hematite. Vein minerals include silica, drusy quartz, calcite, and chlorite.

Mafic Intrusive: dark gray to dark green gray hornblende and plagioclase porphyritic basaltic/andesitic subvolcanic intrusive, with all femic minerals strongly chlorite altered. Locally intense chlorite alteration also occurs in the groundmass and in veins. Other secondary vein minerals include silica, calcite, laumontite,chlorite, trace pyrite (often found associated with chlorite), trace magnetite, and hematite.

T.S.

Ash Rich Volcaniclastic sediments: gray to green gray to dark gray recrystallized volcaniclastic bearing tuffaceous sediments with secondary calcite and localized silica.

Meta-Tuffs: very light gray to light green gray, locally silicified and chloritized, quartz bearing meta-tuff. Quartz, the only surviving primary mineral, occurs as angular to subrounded fragments, containing small white inclusions, fluid inclusions, and trace pyrite. Most of the relict texture of the tuff has been obliterated by subsequent alteration. Secondary minerals include chlorite, replacing femic minerals and some lithic clasts; anhedral albite replacing the groundmass in areas of minor silicification; euhedral albite in areas of intense silicification; cryptocrystalline silica becoming more pervasive with depth; and traces of pyrite as inclusions in quartz and in healed microfractures.

T.S.→

Meta-Tuffs: as above, with the addition of traces of reddish hematite staining.

T.S.→