Report on

Pumpernickel Valley
Geothermal Project
Thermal Gradient Wells

Humboldt County, Nevada

for

Nevada Geothermal Power Inc.
Suite 900, 409 Granville Street
Vancouver, B.C., V6C 1T2

and

Inovision Solutions Inc.
Suite 304, 850 Burrard Street
Vancouver, B.C., V6Z 2J1

and

US Department of Energy
Golden Field Office
Office of Program Management
1617 Cole Blvd.
Golden, CO, 80401-3305

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by

Z. Adam Szybinski, Ph.D.
Fairbank Engineering Ltd.
Suite 901, 409 Granville Street
Vancouver, B.C., Canada, V6C 1T2

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SUMMARY

The Pumpernickel Valley geothermal project area is located near the eastern edge of the Sonoma Range and is positioned within the structurally complex Winnemucca fold and thrust belt of north-central Nevada. A series of approximately north-northeast-striking faults related to the Basin and Range tectonics are superimposed on the earlier structures within the project area, and are responsible for the final overall geometry and distribution of the pre-existing structural features on the property. Two of these faults, the Pumpernickel Valley fault and Edna Mountain fault, are range-bounding and display numerous characteristics typical of strike-slip fault systems. These characteristics, when combined with geophysical data from Shore (2005), indicate the presence of a pull-apart basin, formed within the releasing bend of the Pumpernickel Valley – Edna Mountain fault system.

A substantial body of evidence exists, in the form of available geothermal, geological and geophysical information, to suggest that the property and the pull-apart basin host a structurally controlled, extensive geothermal field. The most evident manifestations of the geothermal activity in the valley are two areas with hot springs, seepages, and wet ground/vegetation anomalies near the Pumpernickel Valley fault, which indicate that the fault focuses the fluid up-flow.

There has not been any geothermal production from the Pumpernickel Valley area, but it was the focus of a limited exploration effort by Magma Power Company. In 1974, the company drilled one exploration/temperature gradient borehole east of the Pumpernickel Valley fault and recorded a thermal gradient of 160^{o}C/km. The 1982 temperature data from five unrelated mineral exploration holes to the north of the Magma well indicated geothermal gradients in a range from 66 to 249^{o}C/km for wells west of the fault, and ~283^{o}C/km in a well next to the fault.

In 2005, Nevada Geothermal Power Company drilled four geothermal gradient wells, PVTG-1, -2, -3, and -4, and all four encountered geothermal fluids. The holes provided valuable water geochemistry, supporting the geothermometry results obtained from the hot springs and Magma well. The temperature data gathered from all the wells clearly indicates the presence of a major plume of thermal water centered on the Pumpernickel Valley fault, and suggests that the main plume is controlled, at least in part, by flow from this fault system.

The temperature data also defines the geothermal resource with gradients >100^{o}C/km, which covers an area a minimum of 8 km^{2}. Structural blocks, down dropped with respect to the Pumpernickel Valley fault, may define an immediate reservoir. The geothermal system almost certainly continues beyond the recently drilled holes and might be open to the east and south, whereas the heat source responsible for the temperatures associated

with this plume has not been intersected and must be at a depth greater than 920 meters (depth of the deepest well – Magma well).

The geological and structural setting and other characteristics of the Pumpernickel Valley geothermal project area are markedly similar to the portions of the nearby Dixie Valley geothermal field. These similarities include, among others, the numerous, unexposed en echelon faults and large-scale pull-apart structure, which in Dixie Valley may host part of the geothermal field.

The Pumpernickel Valley project area, for the majority of which Nevada Geothermal Power Company has geothermal rights, represents a geothermal site with a potential for the discovery of a relatively high temperature reservoir suitable for electric power production. Among locations not previously identified as having high geothermal potential, Pumpernickel Valley has been ranked as one of four sites with the highest potential for electrical power production in Nevada (Shevenell and Garside, 2003).

Richards and Blackwell (2002) estimated the total heat loss and the preliminary production capacity for the entire Pumpernickel Valley geothermal system to be at 35MW. A more conservative estimate, for the hot spring area only, was presented by GeothermEx Inc. (2004), which projected that power generation capacities for the Pumpernickel Valley site are 10 MW-30yrs minimum (probablility of >90%), and most likely 13 MW-30yrs.

PUMPERNICKEL VALLEY GEOTHERMAL PROJECT: THERMAL GRADIENT WELLS

Introduction

This report documents the drilling operations and presents the technical results and information obtained from the thermal gradient wells in the Pumpernickel Valley geothermal project area near Winnemucca, in north-central Nevada. The report incorporates detailed geologic logs, temperature gradients, well construction, and the analyses of the fluid samples collected from the wells. This data is presented in a context of geological and geophysical information obtained prior to and during the drilling program.

The drilling has been a part of an ongoing geological and geophysical program that evaluates in detail the geothermal potential of the Pumpernickel Valley area. The area is located within the well-known Battle Mountain heat flow high and the NE-SW trending geothermal/structural belt, the Humboldt structural zone, which hosts numerous major geothermal fields, including Brady's Hot Springs, Steamboat, Soda Lake, Dixie Valley, and Beowawe (e.g. Blewitt et al., 2003; Faulds et al., 2003).

The geothermal activity within the project area is manifested predominantly by two areas of active hot springs and a wider spread geothermal/hydrothermal alteration halo confined mainly to the hanging wall of the Pumpernickel Valley fault. There has not been any geothermal production from the Pumpernickel Valley property. However, a substantial body of evidence exists, in the form of available geothermal, geological and geophysical information, to suggest that the property hosts a structurally controlled, extensive geothermal field.

Nevada Geothermal Power Inc. and Inovision Solutions Inc., in cooperation with and with funding from the US DOE (GRED III – Phase I, Award DE-FG36-04GO 12340), drilled four thermal gradient wells on private land within the property. PTVG-1 was drilled to ~305 m and approached temperatures of 46.4°C; PVTG-2 was drilled also to ~305 m and reached temperatures of 34.4°C; PVTG-3 was drilled to ~488 m with a temperature high of 80.8°C; and PVTG-J was drilled to ~360 m and intersected temperatures of 45.5°C.

The geothermal gradient well drilling program was designed to map the near surface thermal anomaly implied by previous work and recent geophysical surveys. Following the completion of drilling, down-hole temperature readings were taken in all four wells that revealed anomalous gradients and indicated a considerable extent to the resource.

Location, access, physiography and climate

The Pumpernickel Valley geothermal project is located in Pumpernickel Valley, 30 kilometers east of Winnemucca, in the Basin and Range geomorphic province of northern Nevada (Figure 1). The project is set in the southern portion of Pumpernickel Valley and on eastern slopes of the Sonoma Range, in the southeastern corner of Humboldt County, north-central Nevada. This portion of the valley trends approximately N-S and is flanked by the eastern Sonoma Range to the west, Buffalo Mountain to the east, and by the southern portion of Edna Mountain to the north. To the south, in Pershing County, Pumpernickel Valley is closed by the Tobin Range (Figure 2).

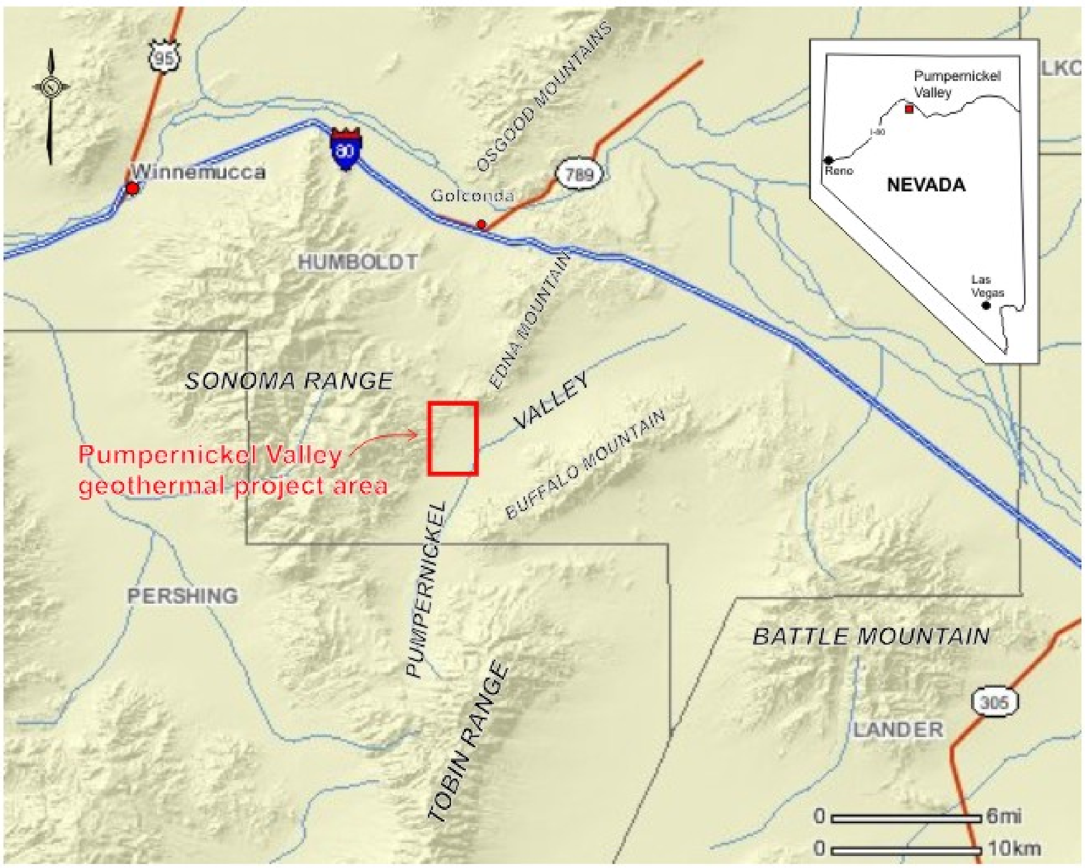

Figure 1. Location of the Pumpernickel Valley geothermal project area in north-central Nevada.

The project area is centered at 40°46'N Lat and 117°28'W Long on the west margin of Pumpernickel Valley. The project area surrounds a cluster of hot springs that occur at 1464-1481 meters elevation above sea level, on the west side of the valley and comprises five sections of private geothermal leases from Newmont USA Limited and four sections of federal lands from the BLM (lease pending), all arranged in a checkerboard manner.

The infilling land belongs to ORMAT and the Tipton Ranch. The configuration of sections included in the project area is provided in Figure 3.

The Pumpernickel geothermal project area is accessible year round traveling from Winnemucca via Interstate Highway I-80, 24 kilometers east to Golconda.

Figure 2. Pumpernickel Valley looking south from the hot springs area towards the Tobin Range. In the foreground alteration associated with the geothermal activity. Note vegetation dominated by sagebrush and desert grasses.

From Golconda 19 kilometers due south, a well-maintained county gravel road leads into Pumpernickel Valley and the project area. Variable and unimproved loose surface tracks provide further access to the western portion of the property.

Within the project area, the land surface is flat to gently sloping into Pumpernickel Valley with elevations ranging from 1,390 m to 1480 m above sea level. In the western portion, the Sonoma Range is moderately sloping up to approx. 1800 m, and characterized by mainly moderate relief, although locally, in the westernmost portion the topography, it is steep. Vegetation consists of typical desert plants dominated by sagebrush, other shrubs, and desert grasses (Figure 2), with areas of desert hardpan without vegetation providing rangeland for cattle and goats.

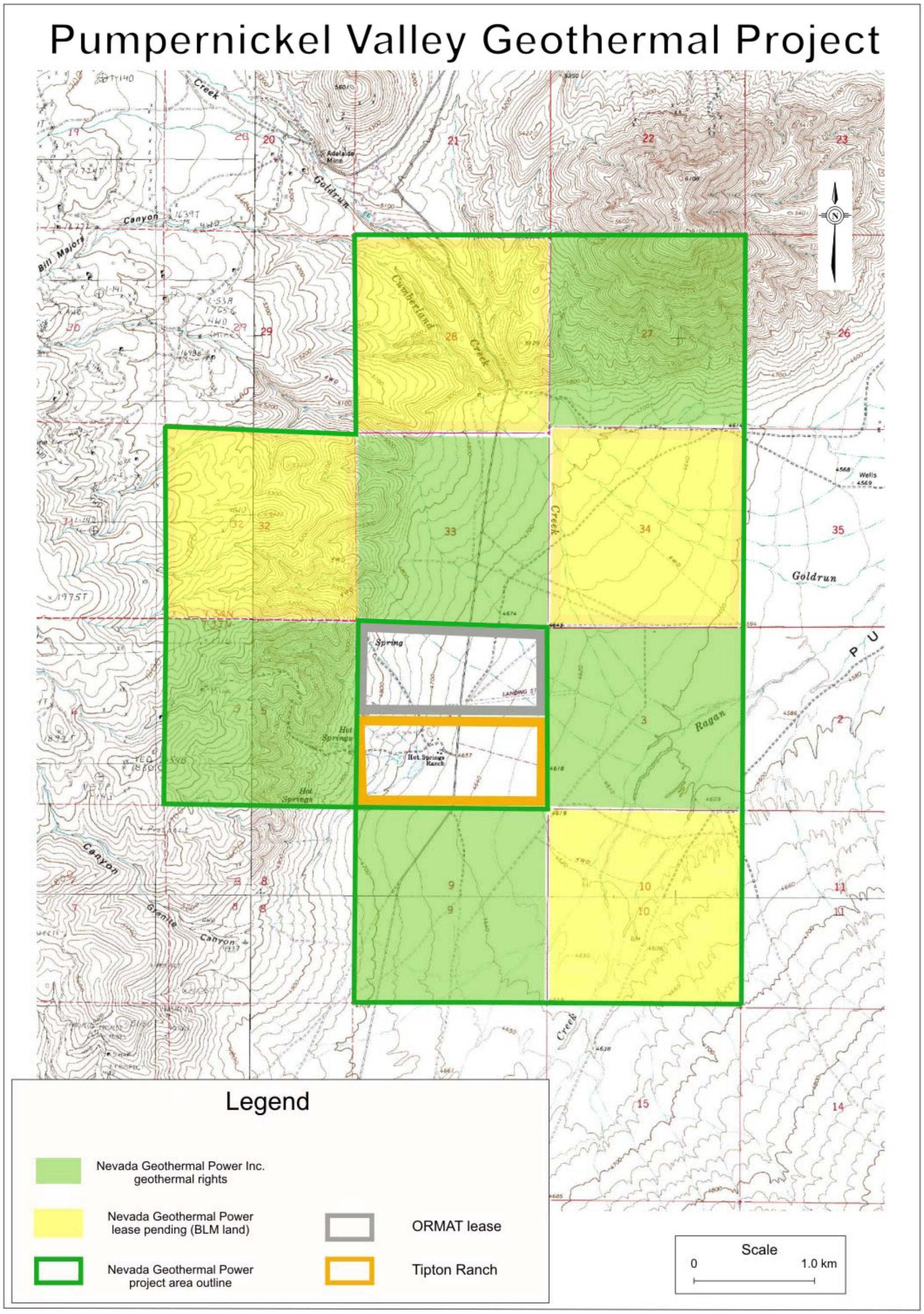

Figure 3. The Pumpernickel Valley project area and outlining geothermal rights.

Pumpernickel Valley forms part of the Humboldt River hydrographic basin and the drainage from the valley is provided by the dry Ragan Creek to the river. The climate is arid to semi-arid. This valley is located in the high desert region and precipitation average 15 cm per annum with the majority of it coming from snow, occasional heavy spring rains, and sporadic summer thunderstorms. The summers are hot and winters generally mild with common overnight freezing conditions. The mean annual temperature is 10.6°C with highs of 40°C.

Power transmission facilities

Several power transmission lines traverse the region and are managed by Sierra Pacific Power Company. A double 345 kV, northeasterly trending power transmission line crosses over the southernmost section of the valley. In addition, a 120 kV transmission line crosses the region, with the Kramer Hill Substation located just south of Golconda.

Previous work

The Pumpernickel Valley area has had a prolific gold mining and mineral exploration history and has been actively explored as evidenced by numerous shafts, pits, trenches, adits, as well as at least three abandoned mines located west and northwest of the valley.

Geothermal exploration in the Pumpernickel Valley was initiated by Magma Power Co. at the Tipton Ranch (Hot Springs) in 1974. The reported temperatures of hot springs at Tipton Ranch were as high as 85ºC, whereas the "best" estimates of the thermal-aquifer temperature were 194-196°C (Mariner and others, 1974; *in* Garside and Schilling, 1979). Magma drilled a single geothermal well to a total depth of 919.6m (3,071 ft - Garside and Schilling, 1979; updated 2003 by Shevenell and Garside, and references therein). The recorded bottom-hole temperature was 135°C, with the last 91 m having a geothermal gradient of 160°C/km (6.5°F/100 ft; S. Matlick, personal comm. *in* Shevenell and Garside, 2003).

In 1981-1982, the University of Nevada System (UNS), under contract to the U.S. Department of Energy (DE-AC08-NV10220), completed a regional assessment of the Pumpernickel Valley area (Trexler et al., 1982; Flynn and Trexler, 1982). The UNS fieldwork included geologic reconnaissance, geochemical sampling, satellite imagery, air photo interpretation, 2-meter depth temperature probe survey, gravity survey, seismic survey, soil mercury survey, and temperature gradient drilling.

The UNS work demonstrated that widespread geothermal fluids are likely channeled to the surface by range bounding faults. Temperatures of geothermal fluids were estimated to be 170°C, based on chemical geothermometers. Mercury anomalies were recorded in soil north from the hot springs along the range front fault.

At this same time, the UNS crew gathered temperature data from seven pre-existing uncased mineral exploration holes found within the present project area. A thermistor probe and digital thermometer were used to record temperature versus depth. Two of these holes positioned near a fossil spring north of the Tipton Ranch had temperatures as high as 43°C at depth of 6 m, and 44.6°C at depth of 4.6 m. Temperatures in other wells located mainly west of the range-bounding fault were lower. The data from five of the holes (Appendix B) were used subsequently to calculate geothermal gradients in a range of 66 to 249° C/km for wells west of the fault, and 283°C/km for a well near the fault (Sadlier-Brown, 2004; revised by this author).

In, 1988, audio-magnetotelluric soundings; telluric and gamma-ray measurement; soil-gas (CO_2, O_2, and hydrocarbons) determinations; soil, pebble-coating, and sagebrush geochemical data were collected along two traverses across the Pumpernickel Fault, with the closest one just 300 m north from the Magma well and hot springs (Erdman et al., 1991). The geophysical and geochemical results from this survey indicated the presence of a buried, possibly mineralized fault east of and parallel to the Pumpernickel fault (*op cit*).

More recently collected magnetotelluric data and a 2-D resistivity model along a profile in the Pumpernickel Valley that included the project area indicated a ~0.4 km thick basin fill underlain by resistive rocks characteristic of the lower Paleozoic units (Rodriguez and Williams, 2002).

In 2002, Shevenell and Garside revisited the Tipton Ranch hot springs as part of the Nevada Bureau of Mines and Geology program focused on evaluation of geothermal resources for electrical power generation and direct-use applications. The Na-K-Ca geothermometers based on new geochemical samples indicated the thermal-aquifer temperature at 175 to 192°C, whereas a more conservative estimate based on the chalcedony geothermometer suggested a geothermal resource with a temperature of 125ºC (Shevenell and Garside, 2003).

In February 2004, Nevada Geothermal Power Inc. acquired geothermal leases to five private sections of geothermal rights in a checkerboard pattern owned by the Newmont USA Limited and subsequently applied for four sections of BLM land (Figure 2). A preliminary geothermal evaluation was completed using the existing data augmented by new mapping and air photo analyses (Sadlier-Brown, 2004). In 2005, Inovision Solutions Inc. acquired an option to earn a 50% joint venture interest in the project.

Tectonic setting of the north-central Nevada

The Pumpernickel Valley geothermal project is located within an extensive zone of recent deformation named the Humboldt structural zone (HSZ) (Faulds et al., 2004). The HSZ (Figure 4) includes mainly east-northeast-striking faults shown to accommodate sinistral and/or normal slip; it is thought to be related to west-northwest-oriented extension within the Basin and Range province.

The HSZ roughly parallels a broad heat-flow anomaly, the Battle Mountain heat-flow high, which also covers much of northern Nevada and forms an east-northeast-trending zone extending from about Reno to Carlin. The HSZ trend correlates well with geothermal activity; productive moderate- and high-temperature, fluid-dominated geothermal systems such as Steamboat, Desert Peak, Brady's Hot Springs, Soda Lake, Rye Patch, Dixie Valley, and Beowawe lie within this zone.

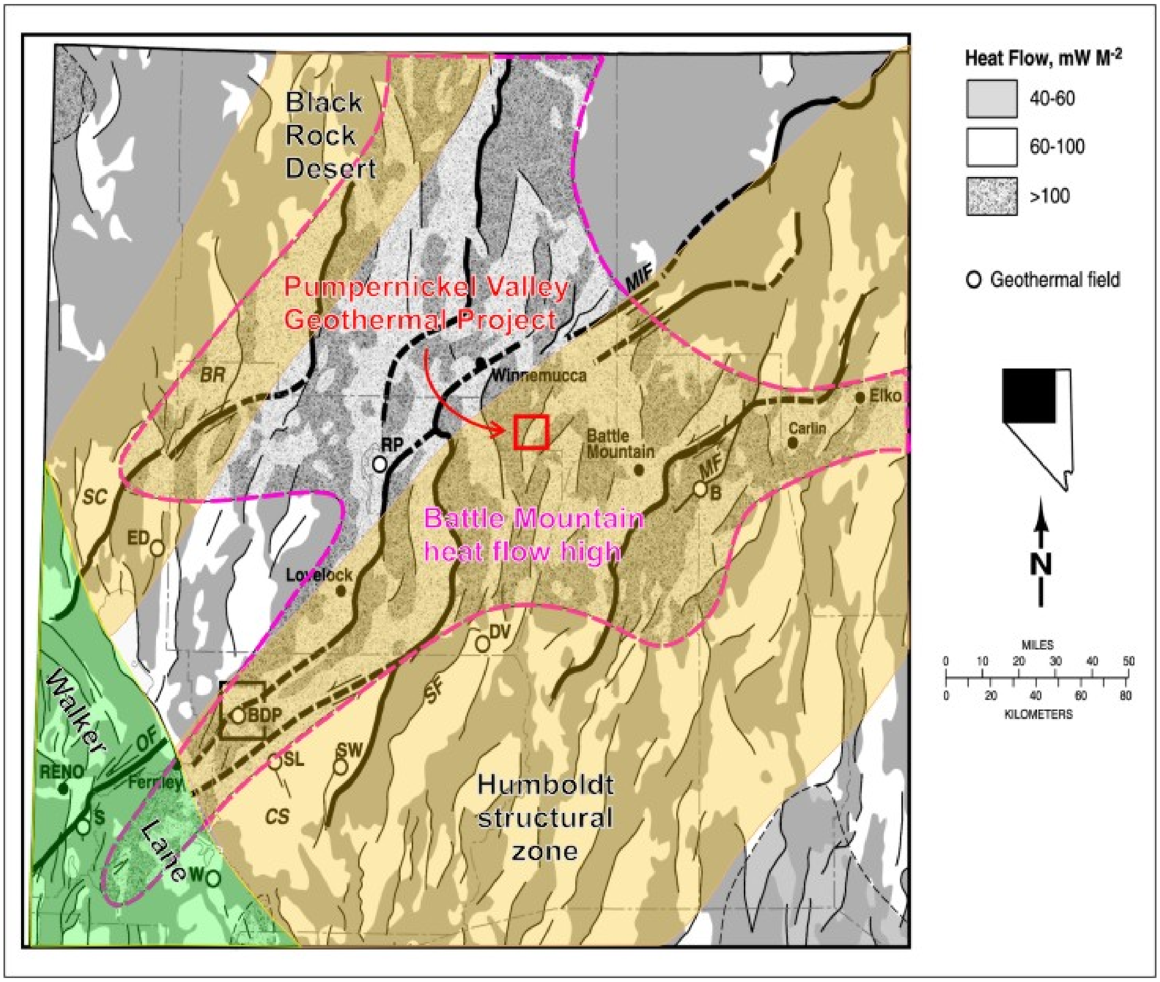

Figure 4. General map of the Battle Mountain heat flow high in northern Nevada (from Faulds et al., 2003) with the superimposed Humboldt structural zone, Black Rock Desert, and Walker Lane belts (modified after Faulds et al., 2004). Bold lines represent major northeast-striking faults. Abbreviations for the relevant geothermal fields are: BDP - Brady-Desert Peak; B - Beowawe; DV - Dixie Valley; S - Steamboat; SL - Soda Lake; SW - Stillwater.

Tectonic extension and high heat flow in northwestern Nevada result most likely from the shallow depth of the Moho (e.g. Louie et al., 2003 and 2004; Lerch et al., 2004). A new crustal refraction profile which follows the HSZ indicated that the crust there is among the thinnest in the Basin and Range (Louie et al., 2003 and 2004). This refraction survey detected anomalously thin crust in the Battle Mountain area, immediately east of Pumpernickel Valley, with a Moho depth of 19-23 km over a region of approximately 150 km wide that is surrounded by more typical, 30-km-thick crust (Figure 5).

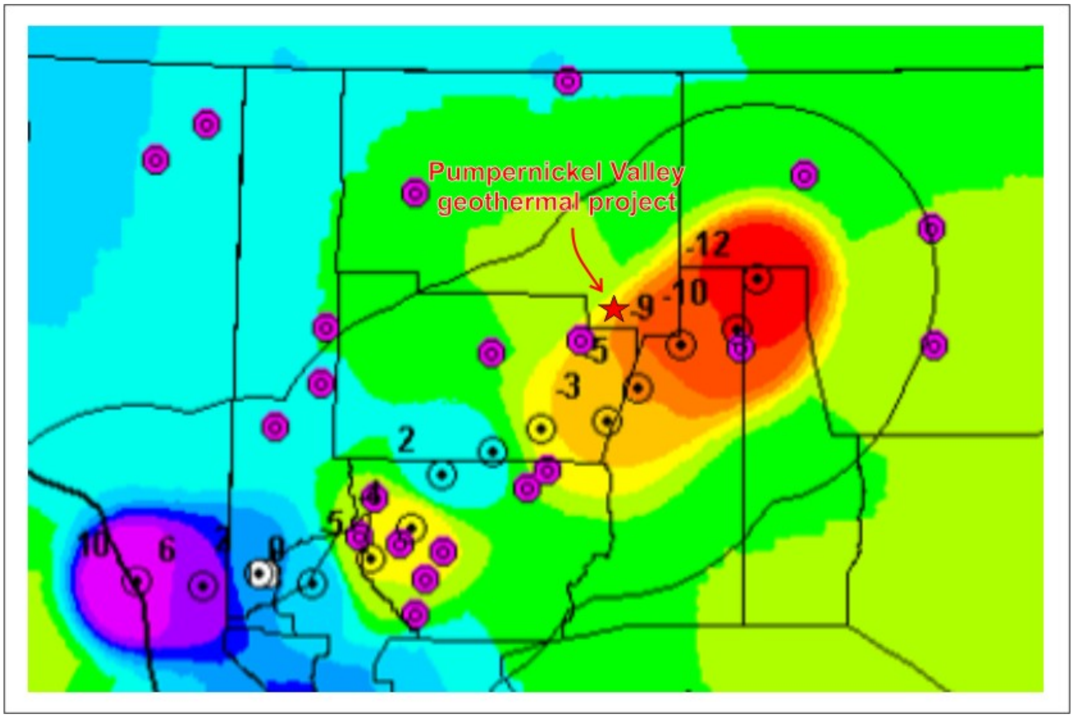

Figure 5. Crustal thicknesses for Nevada from Louie et al. (2004). Warmer colours represent thinner crust; purple circles – extensional-type geothermal systems; circles with dots - new seismic data (numbers refer to the difference between new and old data in km).

Geology of the Pumpernickel Valley area

Regional geology

The Pumpernickel Valley area is located within the structurally complex Winnemucca fold and thrust belt of north-central Nevada that includes three different tectono-stratigraphic units or allochthons (Figure 6). These units are regionally extensive, continue almost uninterrupted throughout numerous northeast-trending ranges, and are comprised of early Triassic Golconda, the Paleozoic Roberts Mountains, and the post-Triassic Mesozoic Winnemucca allochthon (e.g. Stahl, 1989; Ludington et al., 1996; Ketner, 1998; McCollum and McCollum, 2004).

The structural development of these allochthons involves an early, easterly-directed movement of the Roberts rocks during the Antler Orogeny and subsequent eastward thrusting of the Golconda rocks during the Sonoma Orogeny on the top of the Roberts Mountains. After the Antler Orogeny, but before the emplacement of the Golconda allochthon, sedimentary and volcanic strata of Upper Paleozoic age (the overlap succession) were deposited unconformably on deformed rocks of the Roberts Mountains allochthon.

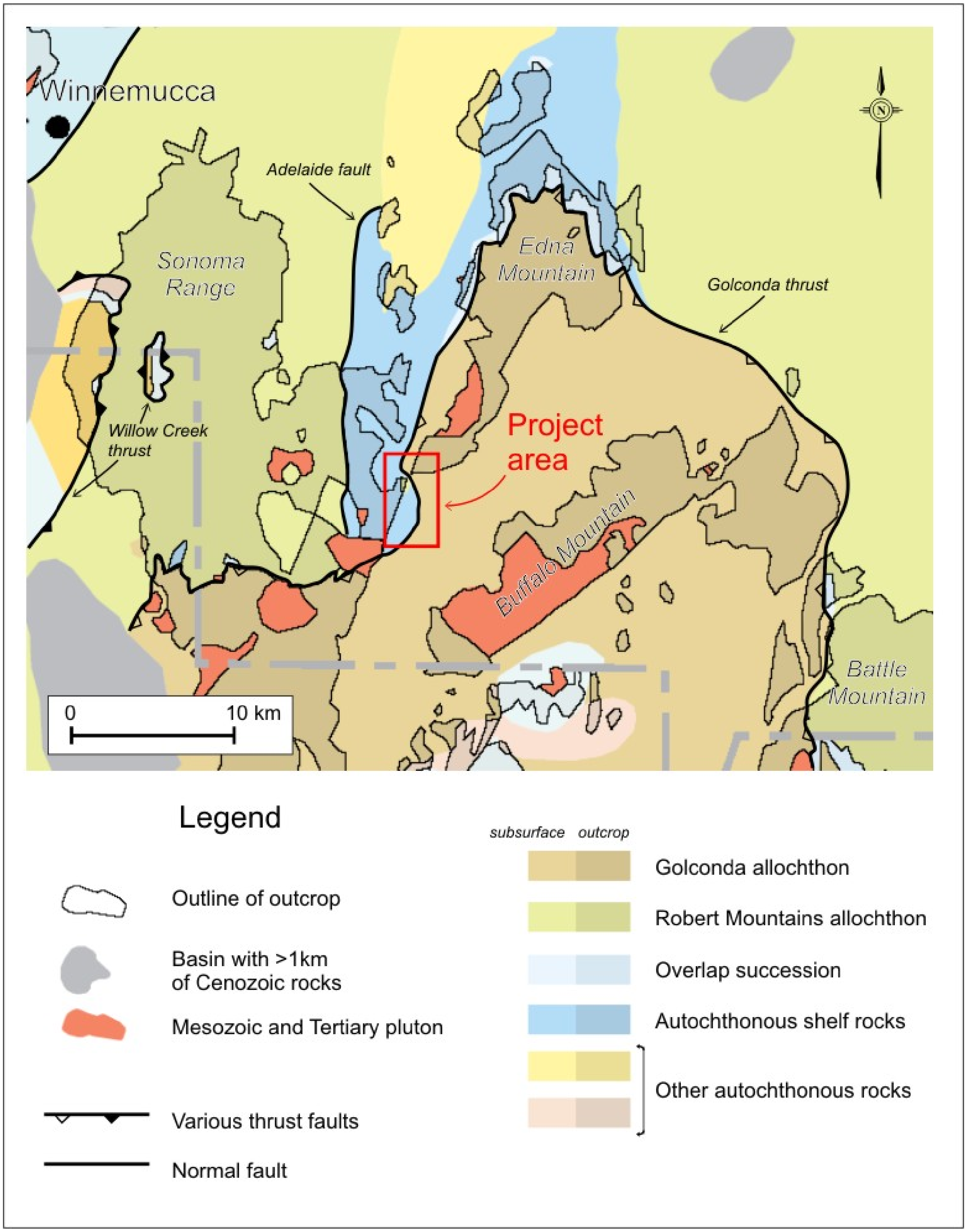

Figure 6. Regional tectonic setting of the project area modified from Ludington et al., 1996.

The Roberts and Golconda rocks were thrust again, this time from east to west, during the Winnemucca Orogeny and incorporated into the Winnemucca allochthon. A post-Winnemucca, Jurassic or Cretaceous orogenic event, characterized by N-S shortening affected the entire Winnemucca allochton.

All these allochtons are locally covered by Tertiary tuffs and other volcanic rocks, and cut by numerous high-angle faults related to the extensional Basin and Range tectonics.

Geology of the project area

The Pumpernickel Valley geothermal project area is underlain by Paleozoic strata included in three major units: the Preble Formation, the Pumpernickel Formation and Havallah Formation, and the Edna Mountain Formation (Figure 7).

Rocks in the western part of the valley and on the eastern slopes of the Sonoma Range are included in the Preble Formation (Silberling, 1975; Marsh and Erickson, 1978). The northern portion of the valley consists of rocks represented by the Havallah sequence of Upper Devonian to Permian age, comprised of dominantly siliceous sedimentary rocks. Rocks of the Edna formation outcrop in the eastern portion of the Sonoma Range, next to Pumpernickel Valley and the range-bounding fault.

Numerous lithostratigrapic repetitions in the area are attributed to tight and isoclinal folding, and the intra-formational imbrication associated with several events of thrusting. The recent overprint by high-angle normal faults related to the Basin and Range tectonism event adds further to the overall complexity.

Preble Formation

In the Pumpernickel Valley area, the Preble Formation consists mainly of strongly deformed sedimentary rocks that are weakly to strongly foliated, regionally metamorphosed to greenschist facies, and locally, near small intrusive bodies, are metamorphosed thermally. Within the project area, the Preble Formation is characterized by polyphase folding and imbricate thrusting (Szybinski, 2005), and the metasedimentary rocks occur in discontinuous, internally strained thrust panels surrounded by variably dipping brittle shear zones. This author concluded that the Preble Formation possibly represents a sequence of merely genetically linked, interleaved thrust slices (*op cit*).

The main body of the formation is comprised of predominantly olive-grey phyllite to quartz mica schist with some quartzite and limestone. A smaller area is underlain by grey to blue-grey, locally recrystallized dolomitic limestone with some phyllite and mudstone.

There are no fossils found locally in the Preble Formation; the Middle Cambrian to Lower Ordovician age of the unit, and the relationship, have been inferred by a correlation with similar dated rocks in the nearby Osgood Mountains (Hotz and Willden, 1964, *in* Silberling, 1975; Madden-McGuire and Marsh, 1991 and references therein; Boskie, 2001).

Pumpernickel Formation and Havallah Formation

The northeastern corner of the property encompasses the southern tip of Edna Mountain, which is the type area of the Golconda thrust. The rock assemblage within the hanging wall of the Golconda thrust (chert, argillite, quartzite, minor limestone, with lesser greenstone of the Upper Carboniferous age) has been originally sub-divided into two litho-tectonic units, the Pumpernickel Formation and Havallah Formation (Marsh and Erickson, 1978).

Numerous subsidiary thrust faults and the associated west-to-northwest-striking folds imbricate and juxtapose the various units. For this reason, in the western Sonoma Range, Silberling (1975) and Stahl (1987) combined both units together as the Havallah sequence. Here, this nomenclature has been applied also to the Pumpernickel Valley area.

Edna Mountain Formation

The Edna Mountain Formation forms a part of the Antler "overlap" sequence, which is structurally overlain by the Golconda allochthon. The formation consists of a mainly brown, blocky weathering, fine- to medium grained, dark-grey calcareous quartzite, locally with black chert fragments; it grades into argillaceous, sandy siltstone. Brachiopod fauna of Late Permian age was found in these rocks along the banks of Goldrun Creek just northwest of the project area (Erickson and Marsh, 1978).

Younger volcanic, intrusive, and sedimentary rocks

Brownish-red, blocky weathering, coarsely porphyritic dykes of probable Upper Cretaceous age intrude rocks of the Preble Formation and follow some of the EW-trending ridges in the western portion of the property.

Intensely altered, grayish-green to cream-coloured quartz diorite dykes and sills intrude rocks of the Preble Formation in the south and central part. Several light-brown to cream in colour, altered quartz porphyry dykes and sills also intrude the Havallah sequence.

Tertiary volcanic rocks in the area include the Oligocene partly welded, rhyolite ashflow tuff, the Miocene vitrophyre or tuff (Figure 8), and Pliocene basaltic flows (Erickson and Marsh, 1978). A high level, poorly sorted, boulder-rich Tertiary gravel covers some ridges and valleys in the map area (Figure 9).

Quaternary deposits

Quaternary alluvium (clay, silt, sand and gravel) fills the Pumpernickel Valley and it is covered with the gravel fans and pediment veneer along the range-bounding faults (Figure 10). Using gravity data and a computer-generated gravity profile, Erickson and Marsh (1978) estimated the thickness of the gravel and alluvium in the western portion of the valley to be less than 100 m.

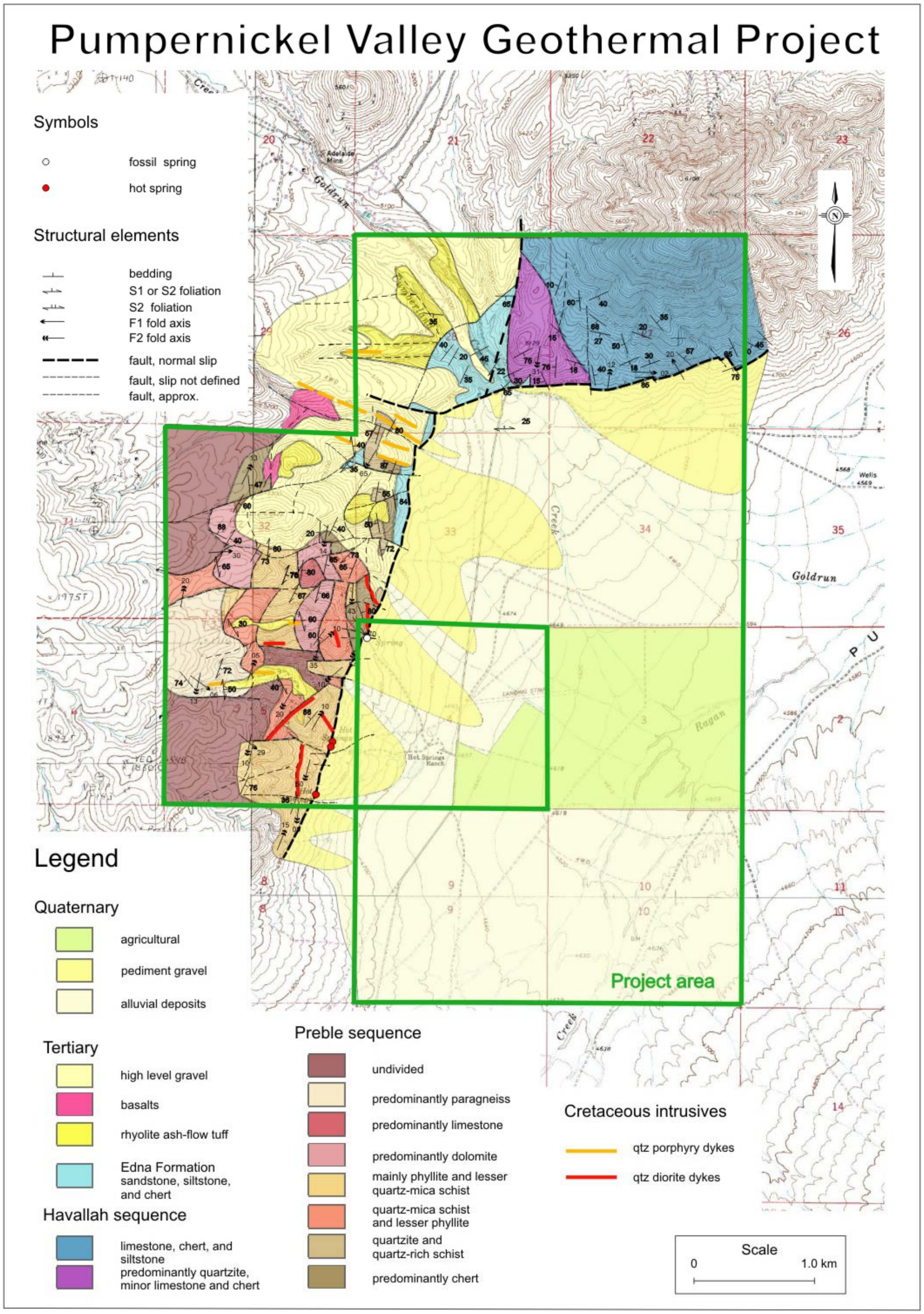

Figure 7. Preliminary geological map of the Pumpernickel Valley project area with additions from Marsh and Erickson (1978).

Figure 8. Outcrop of partly welded, somewhat blocky, Tertiary rhyolite ash-flow tuff on the eastern side of Cumberland Creek, section 28. A similar rock type has been drilled through in the thermal gradient hole PVTG-1.

Figure 9. A typical, poorly sorted and partly consolidated, boulder-rich Tertiary gravel overlying rocks of the Preble Fm. It is exposed in a trench west of the Pumpernickel Valley fault, on the top of a hill in the section 32. A similar rock type forms lower portions of the thermal gradient holes PVTG-1and PVTG-3.

The Magma well, located east of the hot springs on Tipton Ranch, reached basement rocks at a depth of ~186 m (610 feet; Well Drillers Report #14542, Division of Water Resources, State of Nevada, 1975). Approximately northeast of the Magma well, Santa Fe Pacific Mining drilled 213 meters of overburden and the audio-magnetotelluric traverses provided evidence of a buried fault at about 350m depth (Erdman et al., 1991). A recent 2-D resistivity model along the E-W profile within the Pumpernickel Valley project area indicated a relatively shallow, ~0.4 km, basin fill underlain by resistive rocks that are characteristic of the lower Paleozoic units (Rodriguez and Williams, 2002).

Figure 10. A poorly sorted, Quaternary gravel (a mix of a pediment gravel and alluvial deposit) on the floor of Pumpernickel Valley within the north-central portion of the project area. The section is exposed in the sump pit dug near the thermal gradient hole PVTG-3.

Structure of the Pumpernickel Valley project area

The Pumpernickel Valley area is located within a west verging, poly-deformed fold-and-thrust belt, formed as a result of several regional deformation events. As a result, various lithological units occur repeated in a number of discrete, large polyphase fold panels bounded by thrust fault zones and are characterized locally by contrasting structural styles.

Folds, foliations, and minor kinematic features vary in style, orientation, as well as in abundance from panel to panel. There are at least two, and possibly up to four main fold generations, with younger, more open to tight folds refolding earlier tight and isoclinal folds.

Thrust faults are common, but difficult to recognize due to poor exposure and because thrusts are usually parallel or sub-parallel to the foliation fabric and/or to the locally preserved bedding. An extensive network of faults, shear zones, and fractures cut across the folded rocks and anastomoze around lenses of lower strain rocks. The majority of these faults and shear zones, and other structural elements are about parallel to or at an acute angle to the regional ~N trend of lithological units in the Preble Formation.

Many of the fault-bounded blocks within the Preble Formation zone have been the focus of extensive alteration and clearly the bounding faults participated in channeling hydrothermal fluids. The alteration is mainly represented by limonitization and additional leaching and oxidization near the surface.

Basin and Range tectonism

There is a series of approximately north-northeast-striking faults in the eastern Sonoma Range and western Edna Mountain. The majority of these faults exhibit normal displacement, with locally some reverse faulting present, as well. These faults are superimposed on the earlier structures, divide the outcrop into numerous fault-bounded blocks, and are responsible for the final overall geometry and distribution of pre-existing structural features on the property (Figure 11).

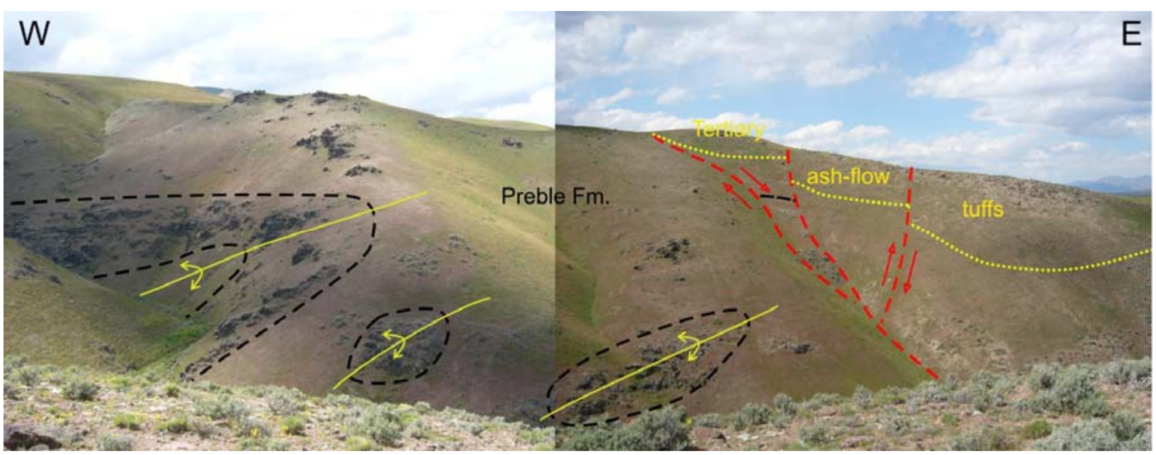

Figure 11. The ~E-W section of the Preble sequence and Tertiary ash-flow tuffs located west of the thermal gradient hole PVTG-2; looking north. The Preble rocks in the west and central part of the section are characterized by a series of the pre-Tertiary tight folds (antiforms outlined by the black dashed lines and axes marked by yellow symbols); red dashed lines indicate the Basin and Range faults (arrows show direction of movement); yellow dotted lines represent approximate contacts between the Preble sequence and the overlying Tertiary ash-flow tuffs.

It appears that the majority of the late brittle normal- and strike-slip deformation took place concurrently with the Basin and Range tectonics. Extension in the eastern portion of the Sonoma Range, near the range-bounding fault, has been relatively significant and is reflected by juxtaposition of the earlier structural elements and stratigraphic displacements of Tertiary volcanic rocks (Figure 11). In the western portion of the project area however, extensional faulting can essentially be regarded as a "noise", superimposed on the generally very well constrained dip-slip kinematic history of the thrust and fault belt.

Major Faults

There are two major faults in the project area, Pumpernickel Valley fault and Edna Mountain fault, and both are considered to represent one fault system by USGS (Anderson, 2000). Both faults are discontinuous, very steep (probably > 75^o), vary in strike, as well as height and shape.

The Pumpernickel Valley fault is the prominent north-northeast trending structure and forms the structural break between the eastern Sonoma Range and western Edna Mountain, and between the Sonoma and southern Pumpernickel Valley basin. Further north, beyond the Edna Mountain fault, a probable extension of the Pumpernickel Valley fault juxtaposes Tertiary volcanic rocks against Paleozoic. The Pumpernickel Valley fault displays a very gradual geomorphic expression typical of an inactive fault front.

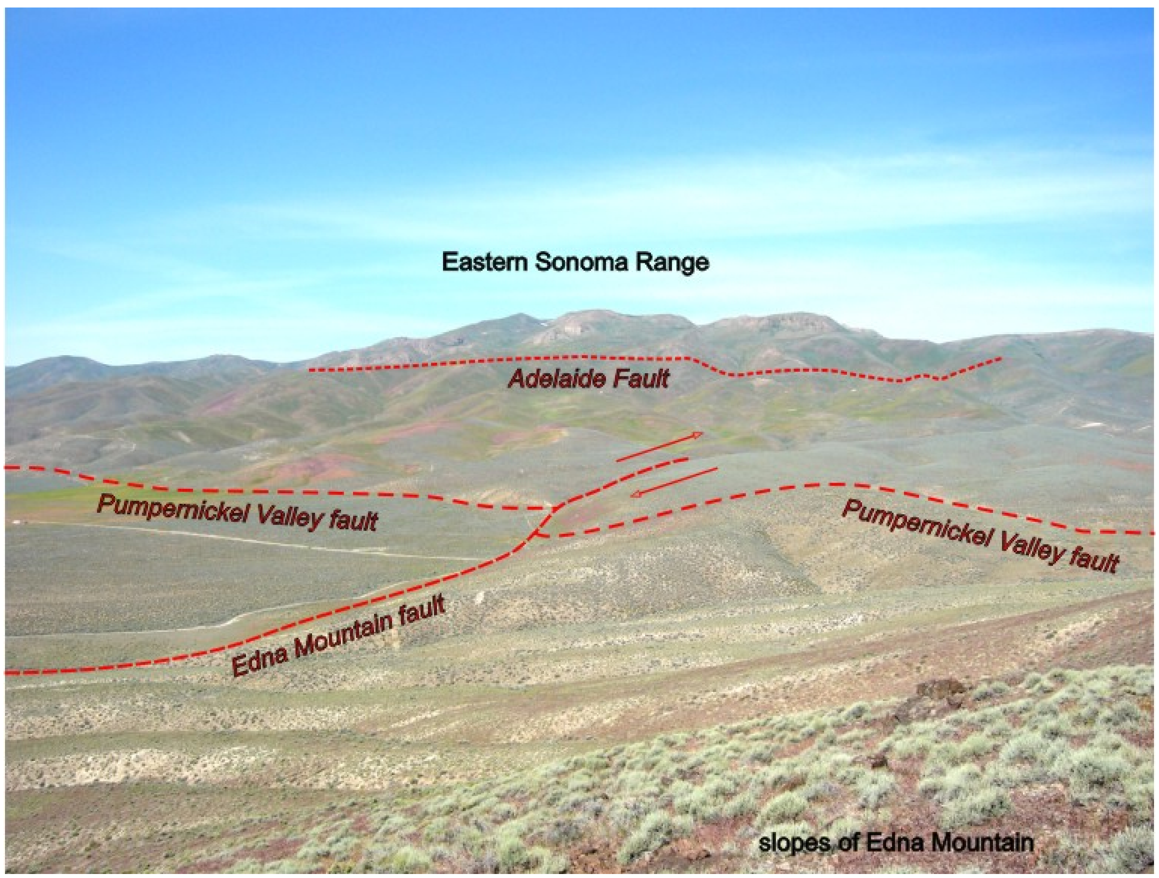

Figure 12. Panoramic view of the eastern Sonoma Range and Pumpernickel Valley area looking WSW from the slope of Edna Mountain; red dashed lines indicate faults referred to in the text; arrows show direction of movement. The Adelaide Fault juxtaposes rocks of the Preble sequence and the Roberts Mountains allochthon (see Figure 6).

The Edna Mountain fault is a discontinuous, in general east-northeast- to northeast-trending structure, which defines the boundary between Edna Mountain and Pumpernickel Valley and juxtaposes bedrock against Quaternary alluvium. The east-northeast-trending portion of the Edna Mountain fault shows a relatively sharp piedmont-to-range break in slope, typical of the recently active major mountain fronts.

The exact sense of movement on either fault has not been established. The down-dip component of movement on both faults is clearly normal. The strike-slip component of the latest movement on the Edna Mountain fault has been dextral strike-slip, as indicated by the nearly vertical, quartz-filled gashes developed in quartzites along the fault trace.

Pumpernickel Valley geothermal system

In the Pumpernickel Valley, active and fossil thermal features were mapped using GPS and aerial photos. The mapped features included both hot and cold springs and seepages, wet soil spots and/or vegetation concentrations, accumulation of salt minerals and sinter/silcrete on the surface, and hydrothermal alteration (Figure 13 and 14). Sinter and silcrete (variably lithified sands, colluvium, roots, etc.) appear to be formed predominantly with calcium carbonate as the cementing agent.

The interpretation of some features was not simple, as the area has been extensively modified by trenching, digs, drilling, and various mining activity. This is the case particularly in the fossil spring area located north of the Tipton Ranch, and that area has not been mapped in detail.

At least two creeks flow from the west into the area occupied by the Pumpernickel Valley fault, and one flows from the northeast into the valley across the Edna Mountain fault; all provide a good seasonal source of water recharge for the geothermal system.

Geothermal features

The most obvious surface manifestation of the geothermal activity in the valley are two clusters of hot springs and wet ground with anomalous vegetation located immediately east of the Pumpernickel Valley fault and west of the Tipton Ranch. The larger of two clusters contains numerous active hot springs that follow a low lying, east-trending and elongate mound of calcareous tufa. The mound seems to be structurally controlled and bounded by a system of faults (Figure 14). Most of these springs display relatively low flow, but the combined discharge from the area has been estimated to be in excess of 400 L/min (Shevenell and Garside, 2003).

The Magma well, which is sited about 400 m east from the Pumpernickel Valley fault and this cluster of springs, spatters continuously at the surface throughout a fracture in the wellhead and the fluid deposits travertine all over the wellhead and surrounding area. The well is artesian with the estimated flow of ~1136 L/min and it marks the easternmost manifestation of the geothermal system (Well drillers report, Log No. 14542).

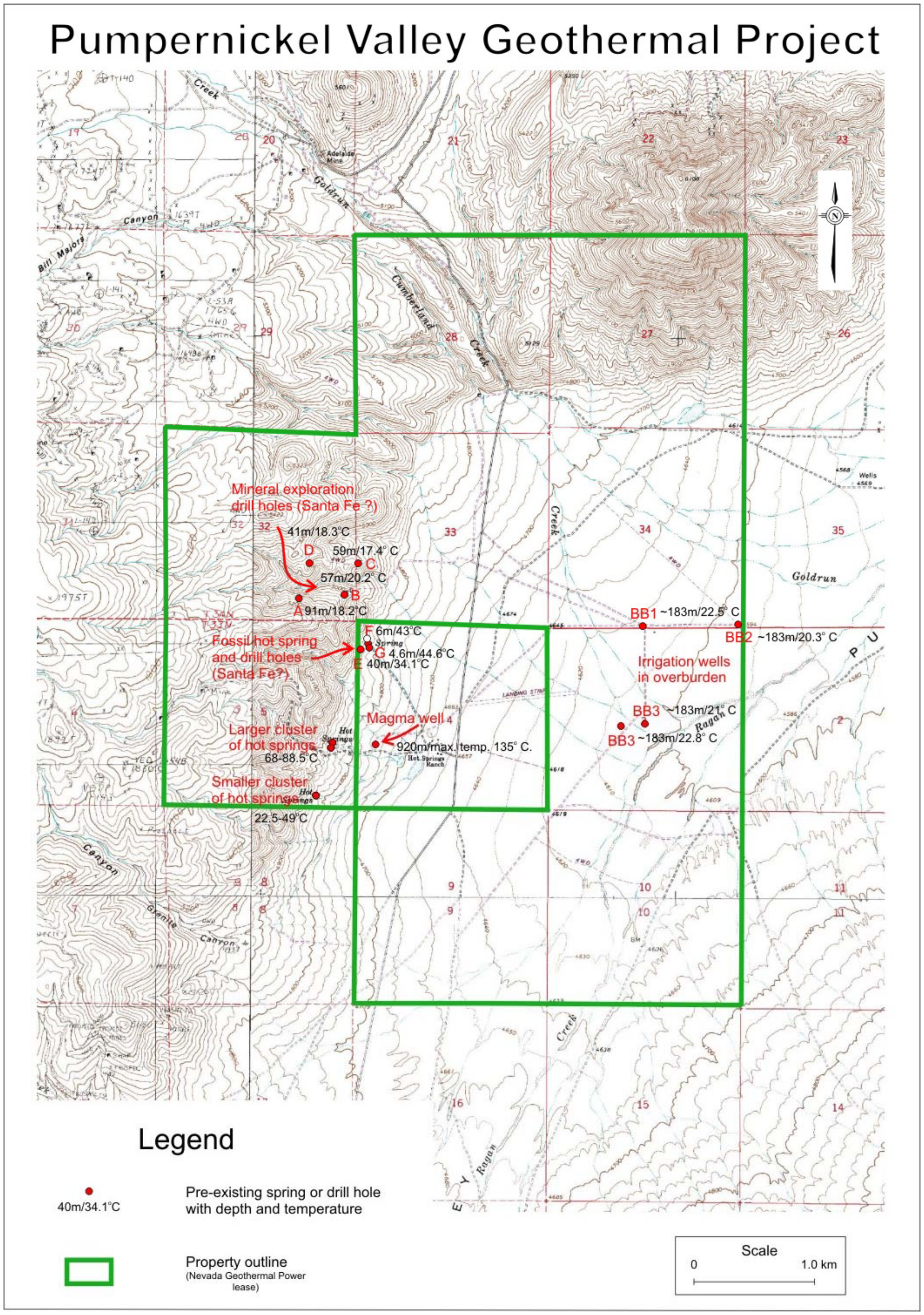

Figure 13. Distribution of the hot spring clusters, location of the Magma well, and other wells with geothermal fluids within the project area. Data from wells A-G are presented in Appendix B.

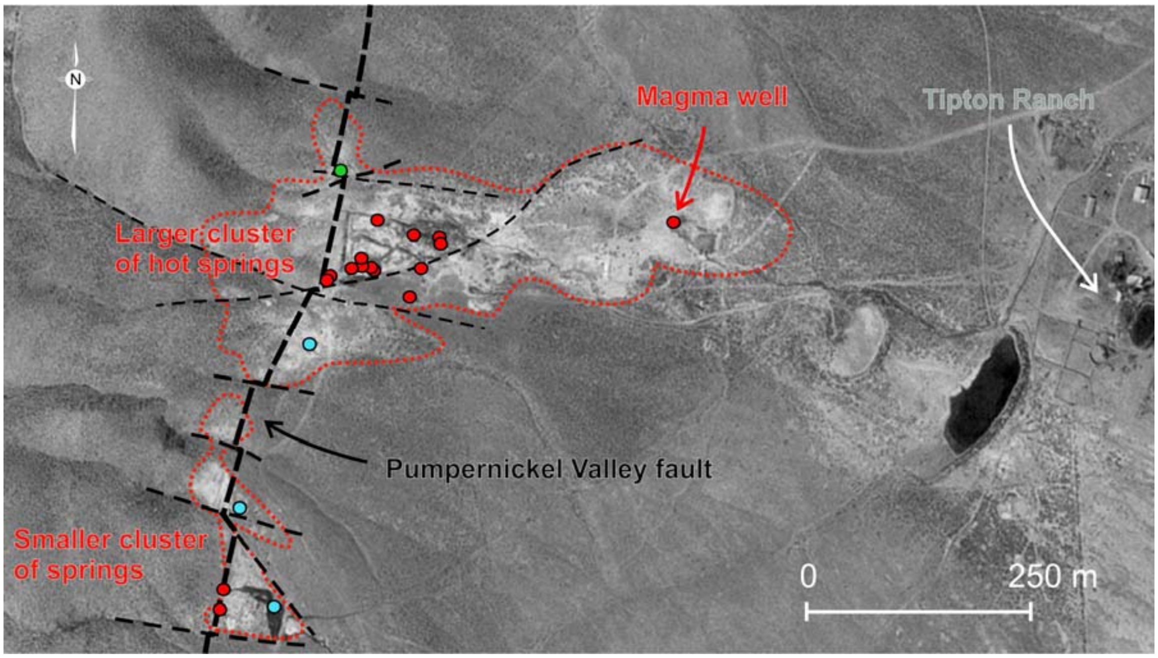

Figure 14. Map of the hot spring and Tipton Ranch area with geothermal features and faults; tufa mounds (sinter and silcrete) are delineated by dotted red lines; hot springs and seepages shown as red dots; cold spring and seepages with anomalous vegetation concentrations shown in blue, whereas the anomalous vegetation only in green. The approximate Pumpernickel Valley fault trace is drawn as a thicker dashed line, whereas probable cross-faults are sketched as thinner dashed lines.

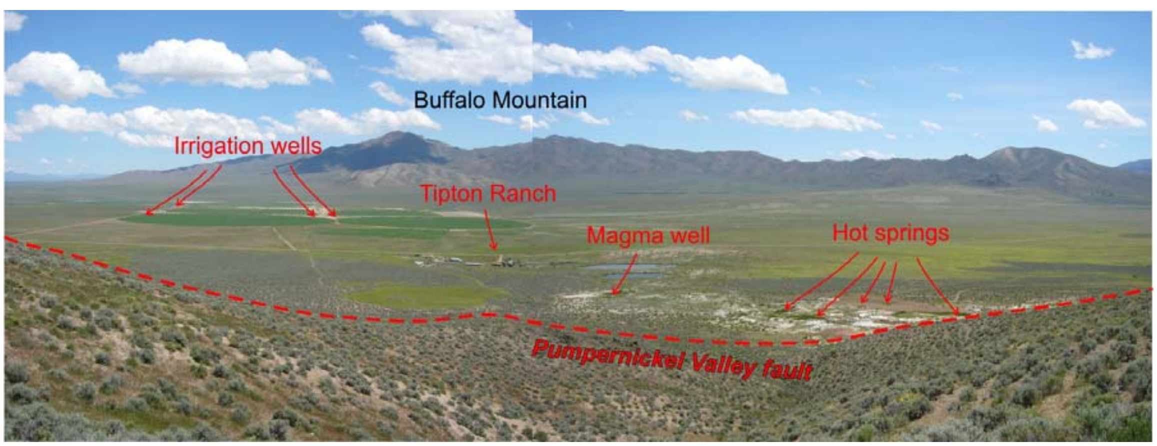

Figure 15. Panoramic view of the Pumpernickel Valley project area looking east from a slope of the eastern Sonoma Range; geothermal features and Tipton Ranch referred to in the text are indicated by red arrows; the red dashed line marks the approximate trace of the Pumpernickel Valley fault. Note the white tufa mound around the hot springs and Magma well.

A smaller cluster of springs and seepages is located along the Pumpernickel Valley fault, south of the main cluster and it represents the southernmost expression of the geothermal system. This area includes a hot spring and creek that flows from it, and a hot seepage.

A mound of travertine deposit (Figure 16) is present between and near both outflows and indicates that the geothermal activity in this area was more prominent in the past and has been diminished by the recent mining exploration (there are several trenches in this area).

Figure 16. Travertine buildup in the southern cluster of hot springs, on and immediately east of the Pumpernickel Valley fault, indicates a pronounced prior geothermal activity associated with the fault. Looking west.

This area is linked with the larger cluster of springs to the north by a patchy zone of tufa. The spring sinter is mainly calcium carbonate, with some travertine, efflioresce, and flower of sulfur. At least one cold spring and two seepages are located in the same area indicating that both geothermal and surface waters utilize the same fault/fracture system associated with the Pumpernickel Valley fault.

Another area located north of the active hot springs and along the trace of the Pumpernickel Valley fault (the northwest corner of section 4) is characterized by an evident halo of strong hydrothermal alteration associated with a fossil spring most likely linked to the currently active geothermal reservoir.

Temperature data

Almost all hot springs within the main cluster exhibit characteristic banded red-and-green algal mats adjacent to the bare spring vents (Figure 17). This allowed an initial, visual estimate of the temperatures in these springs, since the thermophilic algae live in non-acid waters with temperatures ranging 40-70^{o}C (Flynn and Trexler, 1979, and references therein).

Figure 17. A typical hot spring in Pumpernickel Valley with a vent characterized by no algal growth (top left corner of the photo) and indicative of temperatures higher than 70^o C. The green and orange red banding pattern of algal mats surrounding the vent reflects the configuration of isotherms in the cooling geothermal fluid.

The dark green algae Synechococcus sp. exists in temperatures from 55^o to 70^{o}C, whereas the orange red Oscillatoria sp. co-exist with the green algae at the low end of its temperature range (*op cit*). The bulk of the springs on Tipton Ranch have barren zones of no algal growth around spring vents – those are indicative of temperatures higher than 70^o C (Flynn and Trexler, 1979, and references therein). The striking green and red banding pattern of algal mats surrounding the barren vents in these springs, visible downstream, largely reflects the configuration of isotherms in the cooling geothermal fluids (Figure 17).

Thermistor temperature data

The temperature data from the springs, seepages, and other water sources were obtained using a calibrated HOBO thermistor having an accuracy of about 0.1°C. The collected data indicate temperatures in a range from 68 to 88.5^{o}C in the main cluster of springs and 94.5^{o}C in the wellhead of the Magma well. The temperature recorded in the only hot spring in the southern cluster of springs was 49^{o}C, whereas the cool spring and nearby seepages have temperatures 18.9^o C (digital thermometer).

In contrast, a fresh water seepage associated with a strongly altered dioritic dyke west of the main cluster of springs and the Pumpernickel Valley fault has a temperature of 15.5°C.

Water in four irrigation wells, each ~183 m deep, in the eastern portion of the project area, have some geothermal component but also a large proportion of meteoric water and lower temperature readings in a range of 20.3 to 22.75° C.

Resistivity survey

The E-SCAN® 3D resistivity survey performed specifically within the project area (Shore, 2005) shows a broad resistivity-low anomaly associated with the western portion of the Pumpernickel Valley (Figure 18). Three highly conductive areas, A, B, and C defined the center of the anomaly. The anomaly is bounded by numerous linear features arranged in en echelon mode that form two main trends. One trend is NNE and coincides with the trace of the Pumpernickel Valley fault, whereas the other is WNW and oblique to the main trends of faults in the area. The northern portion of the anomaly is clearly bounded by the Edna Mountain fault as well as linear features parallel and oblique to it. Shore (2005) believes that this anomaly represents an aquifer and the points A and B-C may represent structural feeders.

Several smaller resistivity-low anomalies were also delineated and found to be connected by conductive linear features oblique to as well as parallel to the main trend of the Pumpernickel fault (*op cit*). Shore (2005) found this pattern of the smaller anomalies to be consistent with that of hydrothermal alteration, whereas the linking conductive features were interpreted as faults with an alteration envelope.

The general aspects of the resistivity survey are supported by the total magnetic field map, produced by the staff of Fairbank Engineering Ltd.

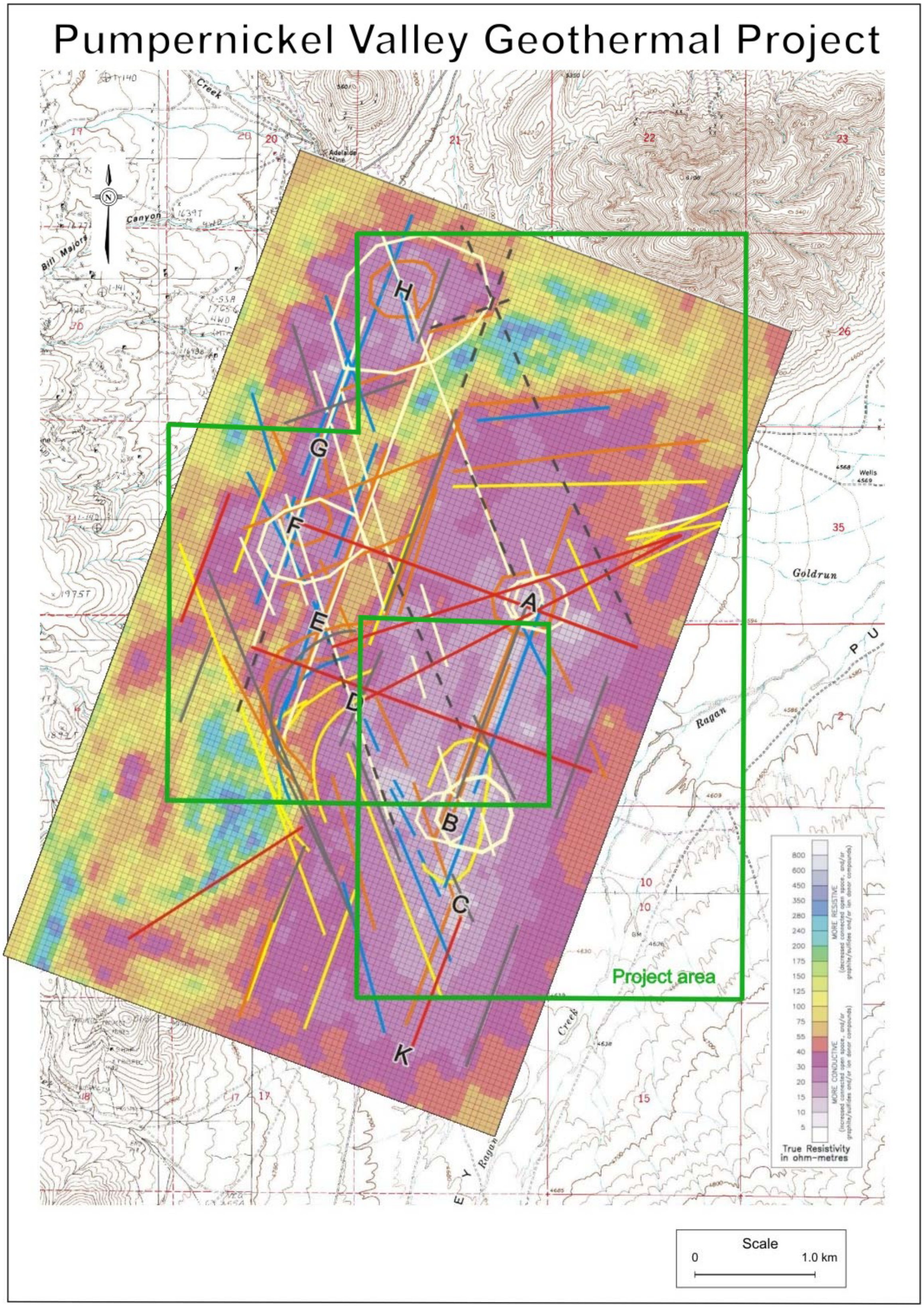

Figure 18. Resistivity map 50 to 75 m below surface contour from Shore (2005). The letters A through H represent centers of geophysical anomalies.

Drilling of the geothermal wells and results

Nevada Geothermal Power Company (former Noramex, wholly owned subsidiary of Nevada Geothermal Power Inc.) planned to drill 6 geothermal gradient wells, each 250 meters deep, on privately leased land in the Pumpernickel Valley project area.

The final locations of these wells were based in part on the results of the geophysical survey and on geological factors. Only 4 wells were drilled, all of which were deeper than originally planned (Figure 19). The project was completed in approximately 4 weeks and all four wells intersected geothermal fluids.

The thermal gradient wells were drilled as a 'step-out' from the original Magma well and confirmed that the thermal anomaly has a considerable aerial distribution. The wells were drilled vertically, first by air rotary, and then mud drilled to various target depths. One water sample was obtained from each well after the first water horizon was encountered.

Well site locations

The thermal gradient wells were drilled to map the aerial distribution of the thermal anomaly. The sites, as well as the access routes, were optimally distributed and selected based on the findings of the recent geophysical survey (Shore, 2005) combined with the results of the previous drilling programs (Magma well; Trexler et al., 1982), and geological data (Szybinski, 2005). Additional aspects taken under consideration were: access to existing dirt roads minimizing surface disturbance and the ease of permitting.

From previous drilling and geophysical surveys in the valley, the anticipated maximum depth to overburden in the center of the project area was estimated to be less than 100m (Erickson and Marsh, 1978). A recent magnetotelluric survey implied ~400m of overburden near the center of the valley (Rodriguez and Williams, 2002). The the 3D-ESCAN resistivity survey by Shore (2005) also indicated that the geothermal reservoir and related structures are most likely located deeper than previously thought.

Consequently, due to the deeper overburden, the number of holes was reduced from 6 to 4 to allow the depth to be extended to between 300-500m. The plan was to rotary air drill (by air rotary casing hammer method) to a depth of ~61m taking water samples as soon as water horizons were intersected, and then switch to rotary mud drill, taking temperature measurements of the mud returns. If bedrock was attained, drilling would continue for another 150m.

The final locations of the wells (Figure 19) were within sections 5 and 9 (T33N, R40E), and on section 33 (T34N, R40E). Each location was marked by four corner posts and surveyed for artifacts by the archeologist Robert K. Vierra, PhD of Reno, Nevada. A Negative Cultural Resources Report (BLM Report CR2-2924(N) and an addendum CR-22924(P)) was filed with the BLM Winnemucca Field Office.

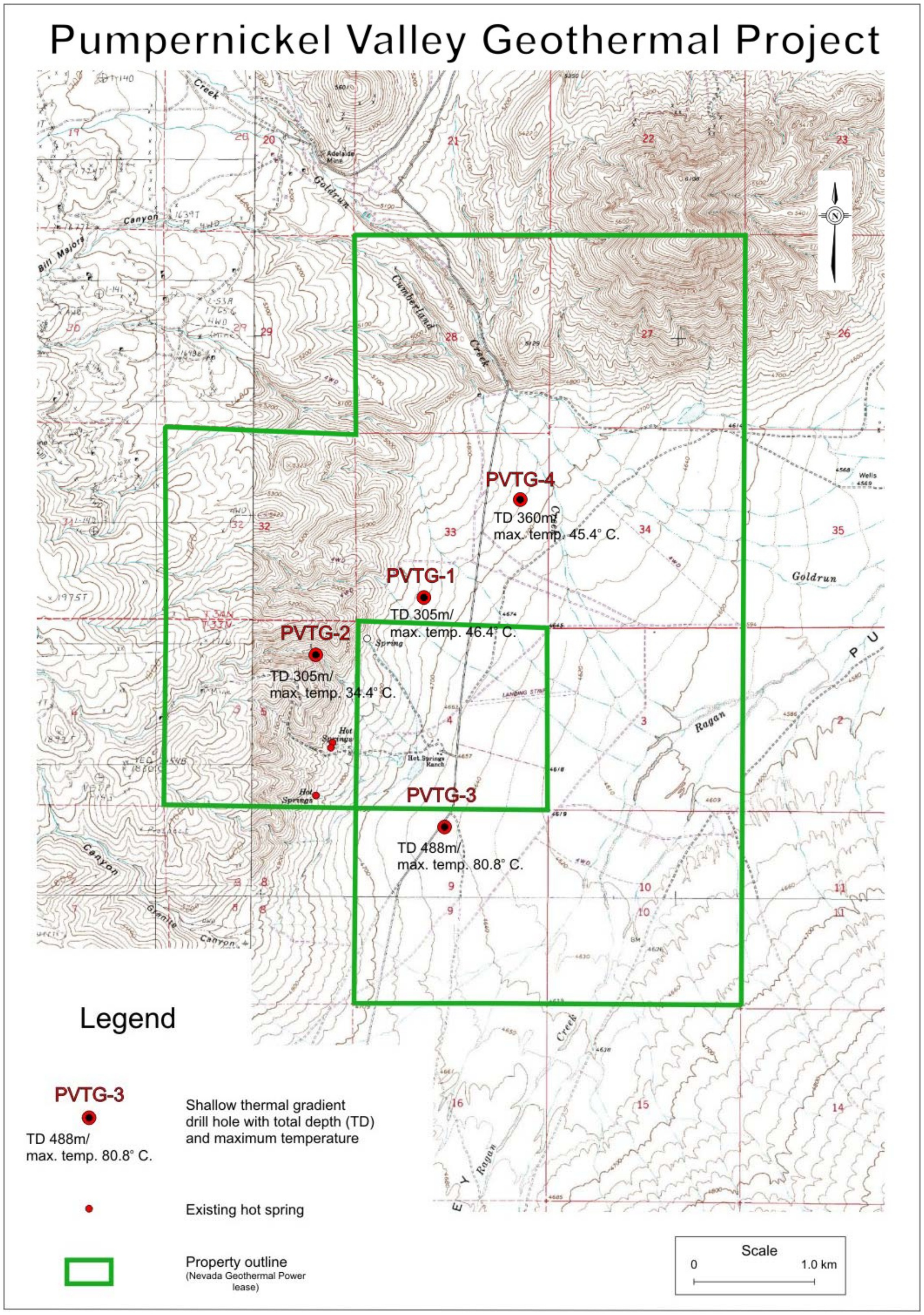

Figure 19. Distribution of the newly drilled geothermal gradient wells within the project area.

No drill site construction was necessary except for PVTG-2, for which the pre-existing mineral exploration site was modified (Figure 20). Access to PVTG-1 and PVTG-2 was provided by the existing dirt roads or trails.

Figure 20. A modified, pre-existing mineral exploration site provided the location for the PVTG-2 borehole. Note the extensive network of trenches in the valley and on hillsides. Looking NE.

Sump pits were excavated at every well site; subsequently they were dewatered and three of these were leveled. The pit on the PVTG-3 site was preserved and is going to be used in the 2006 drilling program. All sites were reclaimed and re-seeded in accordance with state regulations, thus only minimal short-term impacts resulted from this project.

Water for drilling on all sites was trucked in from the well located near the center of the valley (up to approximately 4 km from the farthest well site, PVTG-4), with the permission of the owners, Bob Brewer and Sarah Rosasco of the Rock Creek Ranch.

The wells were designed as vertical, mud rotary drilled gradient holes only intended to obtain temperature measurements and determine thermal gradients, and no blow-out prevention equipment (BOP) was required. The thermal gradient wells were to be terminated immediately if mud return temperatures reached 80°C. A water truck (first 6000 gals, and then 4000 gals) was on site to pump cold water down the well if it became necessary to kill the well. Any excess of well fluid or mud was directed to a sump pit.

Drilling equipment and procedures

A GEFCO Speedstar 30K Tophead Drive air-casing advance/mud rig (Figure 21) was supplied by WDC Exploration & Wells of Elko, Nevada. This truck mounted drill rig is able to advance casing while rotating the drill stem and has a pullback capacity 30,000 lbs and top head drive torque of 5,833 ft lbs.

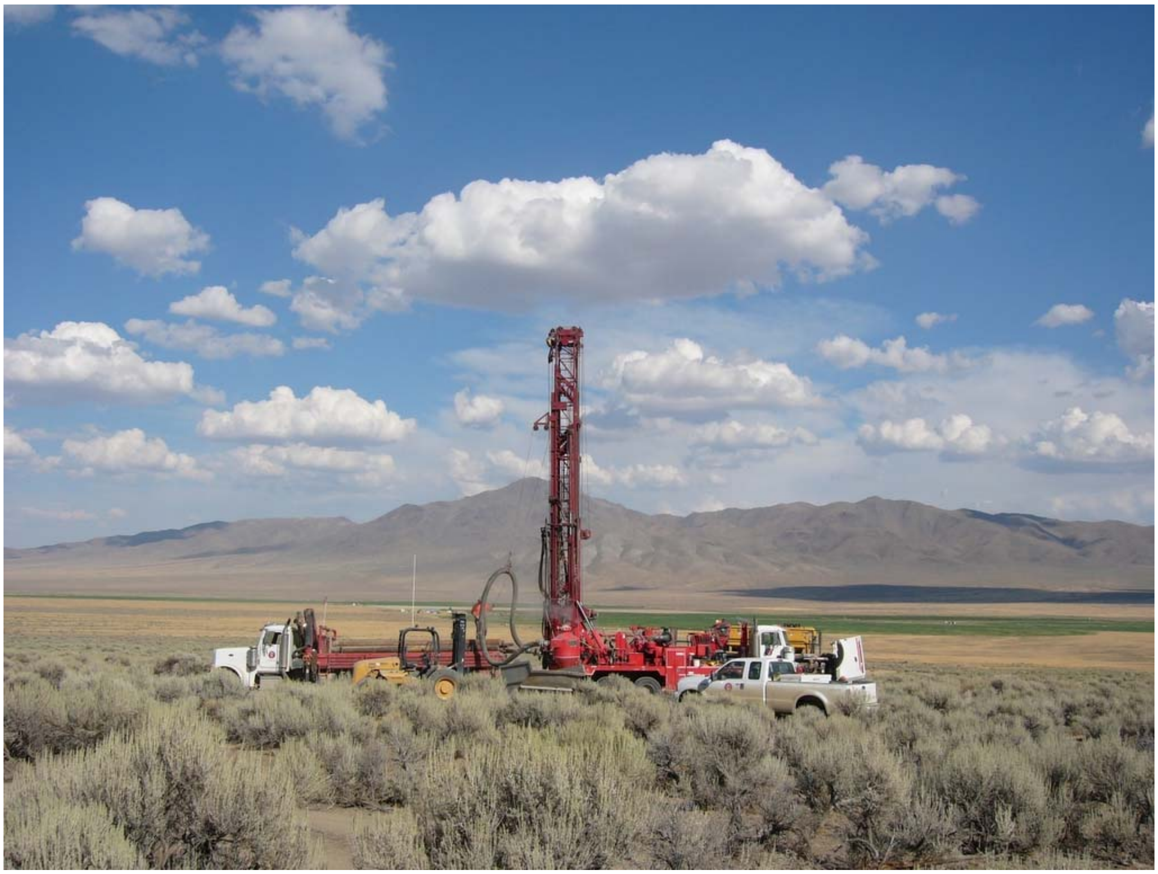

Figure 21. The GEFCO Speedstar 30K Tophead Drive air-casing advance/mud rig used by WDC of Elko, Nevada, to drill all four geothermal gradient holes in the project area. PVTG-1 site, looking ENE.

First the air rotary method was used with air as the drilling fluid to a depth of minimum 61m. Most of the sections were triconed. The 9 7/8 or 9 5/8 inch casing was driven pneumatically in rapid blows into the semi-consolidated overburden in order to prevent the borehole collapse, but was not cemented. The pebbles and/or cuttings were moved out of the hole by the ascending air through the sample hose and into a cyclone (Figure 22), where they were separated from the air.

A minor disadvantage of this method was that pebbles/cuttings in samples were mixed and not always representative of the depth currently being drilled. The advantages included a relatively fast advancement per shift and reasonably easy estimates of water levels.

Figure 22. Compressed air carries cuttings back-up the borehole to the surface. The cyclone separator, shown on the left, slows the air velocity and allows the cuttings to be sampled, before they fall into a container.

Figure 23. Vibrating screens called shale shakers allow separating the cuttings from the mud; the vibratory action of the shakers moves the cuttings down the screens (two black belts in the center of the device) where they can be sampled, and subsequently moved to the sump pit. PVTG-3 site.

Subsequently, below ~61m, the mud rotary method was used in which the rapidly rotating drill bit cut the overburden or rocks and advanced the borehole. The gravel and/or cuttings were removed by drilling fluid (water mixed with mud), which flowed into a shaker (Figure 23) from which the cuttings were constantly moved out to the sump pit, whereas the fluid was pumped back down the drill rods. In addition, the fluid cooled the bits and prevented the drill holes from collapsing in unconsolidated formations below the casing.

Whereas this method is equally fast or faster than air drilling, it had certain disadvantages, which included the inability to immediately determine water levels and to sample them, as well as the loss of circulation and fluid in strongly faulted rocks. Large amounts of the water based drilling fluid flowing in the drill holes caused some difficulties where clays were present. Swelling clays narrowed the hole and plugged drill bits in PVTG-3. Pebbles and/or cuttings are also mixed in this method and don't accurately represent lithologies at a given drilling depth.

PVTG-1 was air drilled to ~97.5m and the 9 7/8" casing was hammered to this same depth, at which point the rig was converted to mud. The hole, drilled with the Tricone bit 8.5" reached the depth of 305m, still in overburden. Water with the temperature of 25^{o}C was intercepted at ~91.5m. Drilling fluid with an average viscosity of 48-50 containing bentonite (Kwik-Plug Fine Wyoming Bentonite) and some polymer (polypac) was used. The mud-return temperature reached a maximum of 41.2°C near the bottom of this hole.

PVTG-2 was air drilled to ~73m, first with the hammer bit 9 7/8" and Stratex shoe, then with the hammer bit 8.5" and conventional shoe, and finally with Tricone bit 7 7/8". The hole encountered bedrock at ~15m, first water in fractures at ~20.5m, and the well was completed to 305m. The average mud viscosity was ~40, whereas the maximum-mud return temperature recorded was 40.5°C at ~247m depth.

In PVTG-3, overburden was deeper than anticipated. The hole did not reach bedrock and the drill rig had reached its capabilities at a depth of ~488m. It was air drilled first to ~61m and at this same time the 9 7/8" casing was hammered in; the bit used was Tricone 8.5". Subsequently the rig was converted to mud and Milltooth Tricone 8.5" and button bit 8.5" were used. The Hobo thermistor temperature recorded at the bottom of well was ~81°C. The mud viscosity in the upper portion of the hole was 30 and quickly went to maximum 49 at ~330m, after which it was lowered to ~45. The maximum mud-return temperature of 48.5°C was reached at a depth of ~408-445m.

PVTG-4, which was originally permitted to 300 m, had its depth extended to 400 m by filing a "Sundry Notice" with the Division of Minerals (DOM). The hole was air drilled with the Tricone bit 8.5" and casing 9 5/8" hammered in to ~61m. After conversion to mud, the 7 7/8" Tricone bit was used. Bedrock was intersected at 201m, but at ~358.5m the hole intercepted a major fracture and lost circulation. Attempts to restore the circulation failed and the hole was stopped at 360m. Mud viscosity went from the initial

35 to 42 at approx. -150m and stayed at ~40-42 until end of this hole. The mud-return temperature reached a maximum of 38.2°C near -1150m.
PVTG-1, 2, and 4 were lined with two-inch flush joint black steel pipe, capped at the bottom. The conductor casing was pulled and the annulus was sealed with cement (with an addition of bentonite chips in PVTG-4) to surface. The 2 inch pipes were filled with water, capped, and have been monitored, enabling temperature gradients to be measured over the course of the project. In the PVTG-3 well, the 4.5 inch casing was cemented back to surface in order that it could be deepened at a later date with other drilling equipment. All four wells are locked.

For the well designs and detailed information on the lithology and temperatures see chapters “Geology of the drill holes” and “Temperatures data and gradients”.

Logging

The author was on the site throughout the drilling operations to log the drill cuttings and coordinate with the drilling staff. Small representative samples of the gravel and/or chips were collected approximately every 3m, sieved and washed by the geological technician, and examined by the author. A preliminary written description of the cuttings was prepared. Afterwards, the samples were packed in small cotton bags, transported to

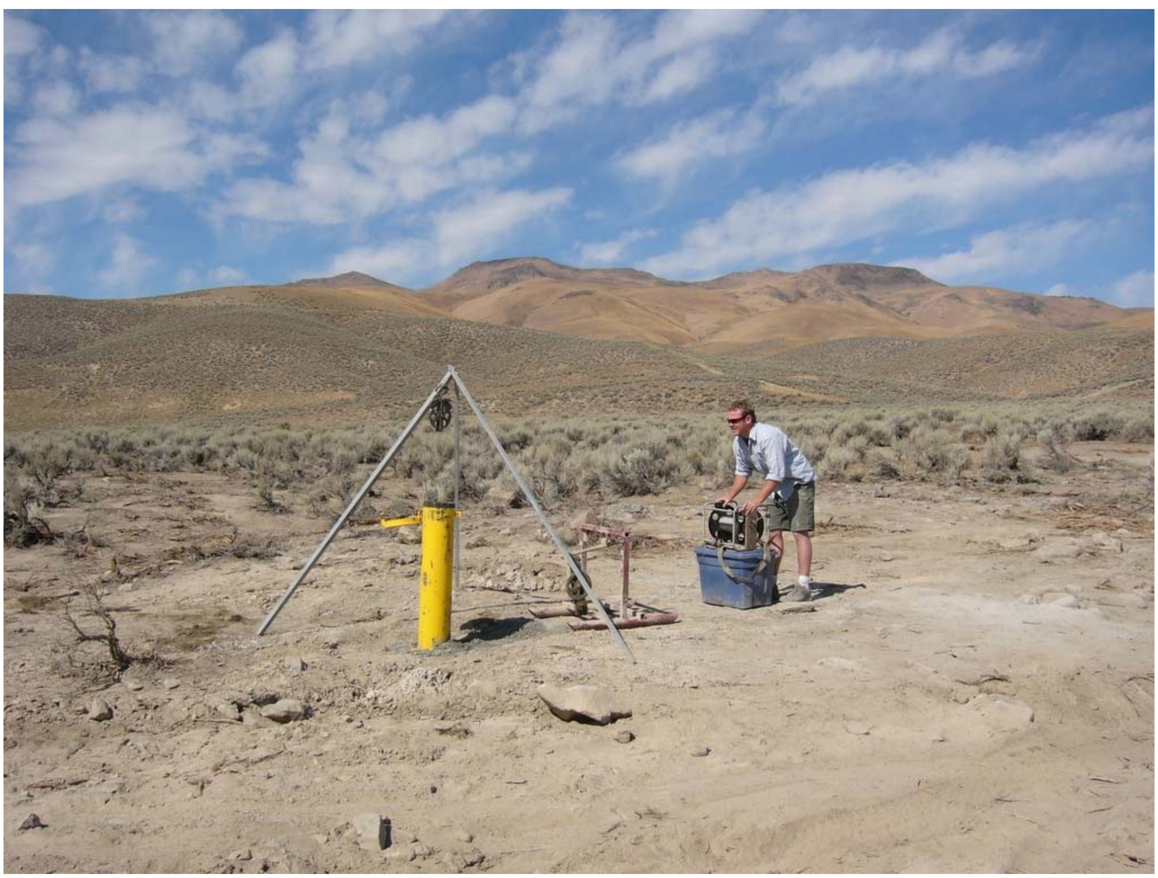

Figure 24. A typical Hobo thermistor setup, which includes wire-line reel, counter, and tripod with down-hole pulley. Ryan Nelson during the survey on PVTG-1.

the warehouse located at the Nevada Geothermal office in Winnemucca and dried. Dry samples were split and a portion of each sample was placed in chip trays (plastic boxes with compartments). The samples were examined again under a microscope and tested for effervescence with 10% HCl, and the drill hole logs were updated. One set of chip samples were sent to the Nevada Bureau of Mines and Geology (NBMG), University of Nevada-Reno.

While drilling, in every hole, the first water encountered was airlifted to surface and sampled for geochemistry, and the water temperature registered. The samples, together with several other samples taken from nearby springs, existing wells, and creeks, were prepared and sent to Thermochem Labs in Santa Rosa, CA for analyses. These samples provided baseline data of the geothermometry of the area. Temperatures of the mud return were monitored using digital thermometers. Once drilling was completed further temperature surveys were taken using the Hobo thermistor probe, provided by Fairbank Engineering Ltd. This yielded detailed temperature gradients and equilibrated temperature profiles after the wells completion (Figure 24).

Geology of the drill holes

Three out of four holes were drilled in Pumpernickel Valley. The valley geology is dominated by the fill sediments represented by alluvium and piedmont gravels. The alluvium is dominantly Quaternary in age, although there are the late-Tertiary alluvial deposits as well. Where drilled, the thickness of the alluvium ranges from 200m to over 488m, although gravity data (Marsh and Erickson, 1978) suggested alluvial thicknesses may be significantly thinner in the western portion of the project area. The alluvium consists of partially cemented sand, sandy gravel, pebble-gravel and variable, discontinuous deposits of sand, silt, and mud. The alluvial section in the well PVTG-1 also contains thick lenses of tuffs.

The PVTG-1 hole (Figure 25) was located ~333m ESE from the Pumpernickel Valley fault and drilled to a total depth of 305m; it didn't reach the bedrock. Water with the temperature of 21^{o}C was intercepted at ~61m. However, the hole intersected two horizons of Tertiary ashflow tuffs (one at least 50m thick) sandwiched between layers of probably clay-supported and partly solidified Tertiary(?) gravel. The pebbles composition in the upper portion of the hole (Ouaternary alluvial deposits) is represented dominantly by the Preble Formation lithologies, though up to 30% granitic and felsic sub-volcanic intrusive rocks are present.

The PVTG-2 hole (Figure 26) was drilled ~290m NW from the Pumpernickel Valley fault and drilled to a total depth of -305m. Almost the entire length of the hole was in the weakly limey, probably dolomitized and locally siliceous mudstones of the Preble

Formation. Most of the mudstone is marked by the locally widespread quartz veinlets with minor, various amounts of fine disseminated pyrite. Pyrite also forms a thin film on numerous fractures. Only the first 15m of the hole was in the Quaternary alluvial deposits with pebbles and chips of exclusively metasedimentary rocks of the Preble Formation. In this hole, the first water was intercepted in fractures at -20.5m, with a better flow at -30.5m and a temperature of 14^{o}C.

PVTG-3 (Figure 27) was set to test the largest conductivity-high (anomaly B) delineated by the 3D-ESCAN resistivity survey (Shore, 2005). It was located in the southern portion of the project area and drilled to a total depth of -488m; it did not reach bedrock. The hole intersected numerous layers of probably clay-supported Quaternary, and subsequently likely Tertiary(?), gravel. Pebble composition in the majority of layers is dominantly, and locally almost exclusively, the Preble Formation, though in the uppermost, mud-drilled Quaternary horizon up to 70% of the pebbles are of granitic composition and up to 15% of the pebbles are quartz. Down the hole, the amount of granitic pebbles is significantly smaller and decreasing, and near the bottom of this hole pebbles of volcanic rocks are present and form up to 12%. This relationship may reflect the process of un-roofing of a nearby volcanic/intrusive center, such as the one in Granite Canyon (located ~2km due SW from PVTG-3). Chips of pale bluish green and lesser orange siltstone-like rock were found among the gravel near the bottom of the hole and may represent deposition from ascending geothermal fluids and/or alteration of the clays. The first water in this hole was intercepted at ~36.5m, with a slightly better flow at -42.5m and a temperature of 15^{o}C.

The PVTG-4 hole (Figure 28) was drilled ~880m S from the Edna Mountain fault and ~900m E from the Pumpernickel Valley fault, to a total depth of -360m. The first 200m of the hole is set in several layers of most likely clay-supported Quaternary and Tertiary(?) gravel. Pebble composition in the majority of layers is dominantly, and in some layers almost entirely, of the Preble Formation and Havallah sequence rocks. However, in some layers, up to 20% of the pebbles are of granitic composition. The other half of this hole is comprised of quartz sandstones, quartzites, and cherts of the Edna Formation. These rocks are variably veined with quartz. At the bottom of this hole, a prominent open fracture is present. Water with a temperature of 21^{o}C was intercepted at -61m.

The following schematic diagrams from the thermal gradient wells indicate well designs and general down-hole lithology changes. For detailed geologic descriptions refer to the chip logs in Appendix B.

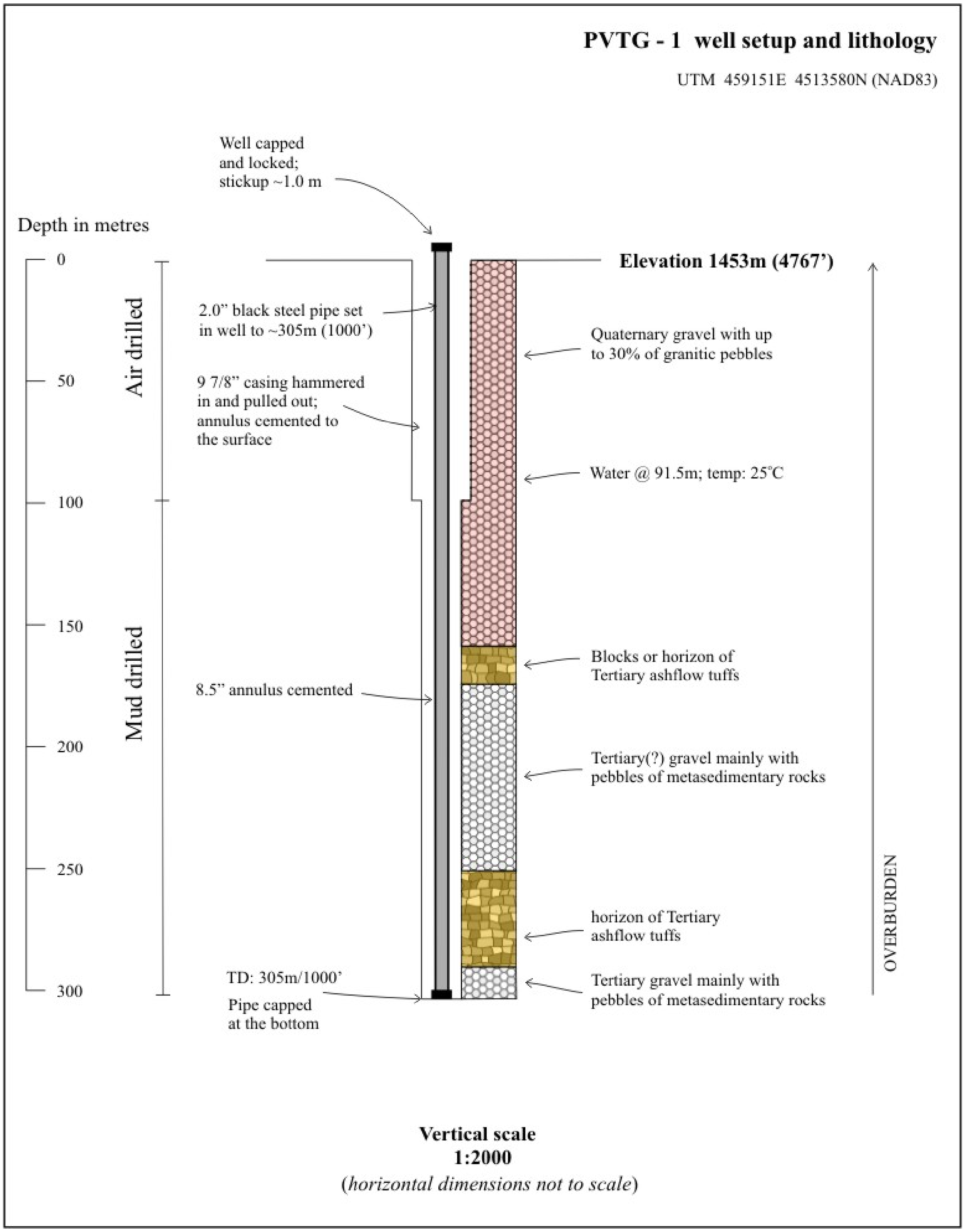

Figure 25. The PVTG-1 well setup and down-hole lithology.

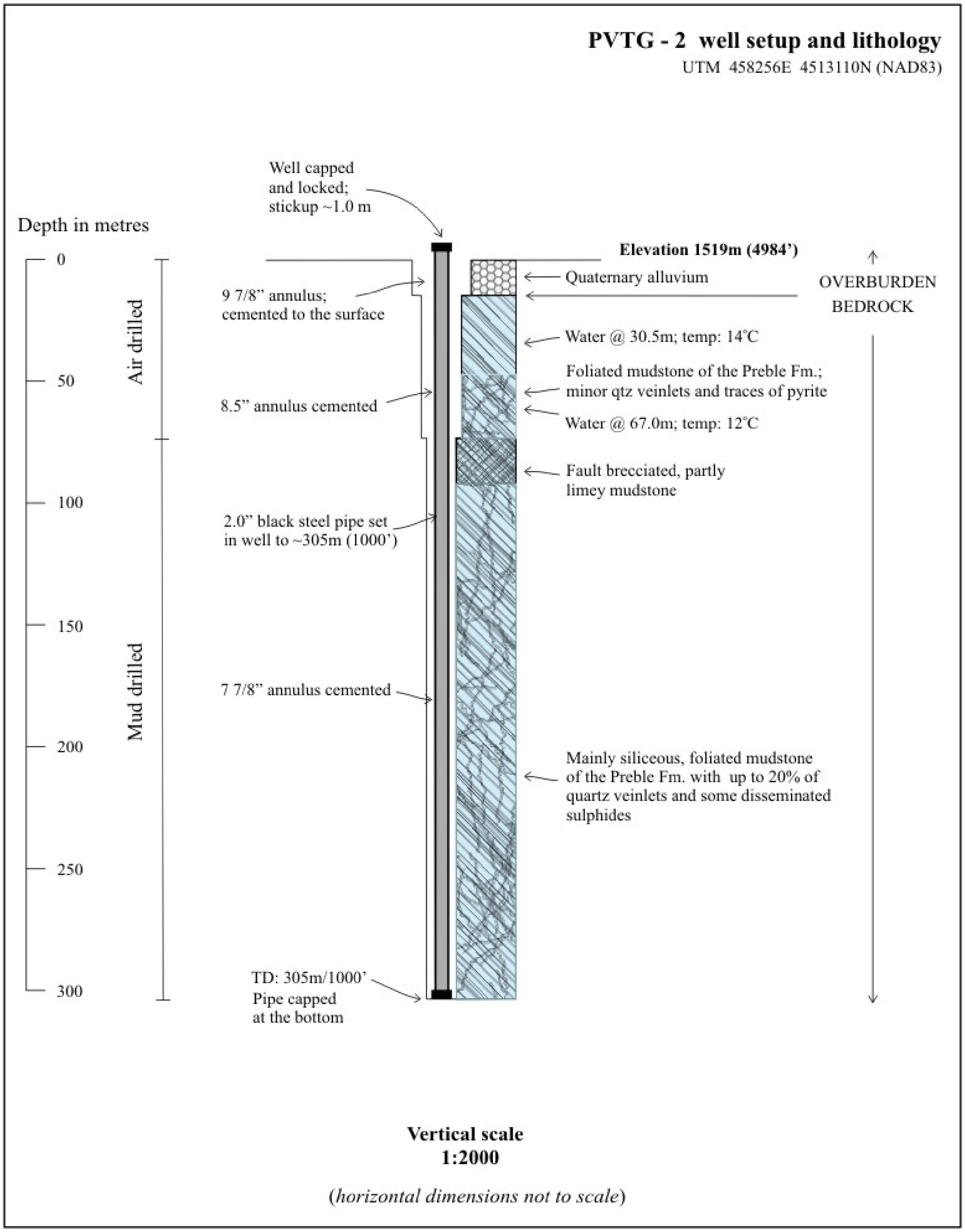

Figure 26. The PVTG-2 well setup and down-hole lithology.

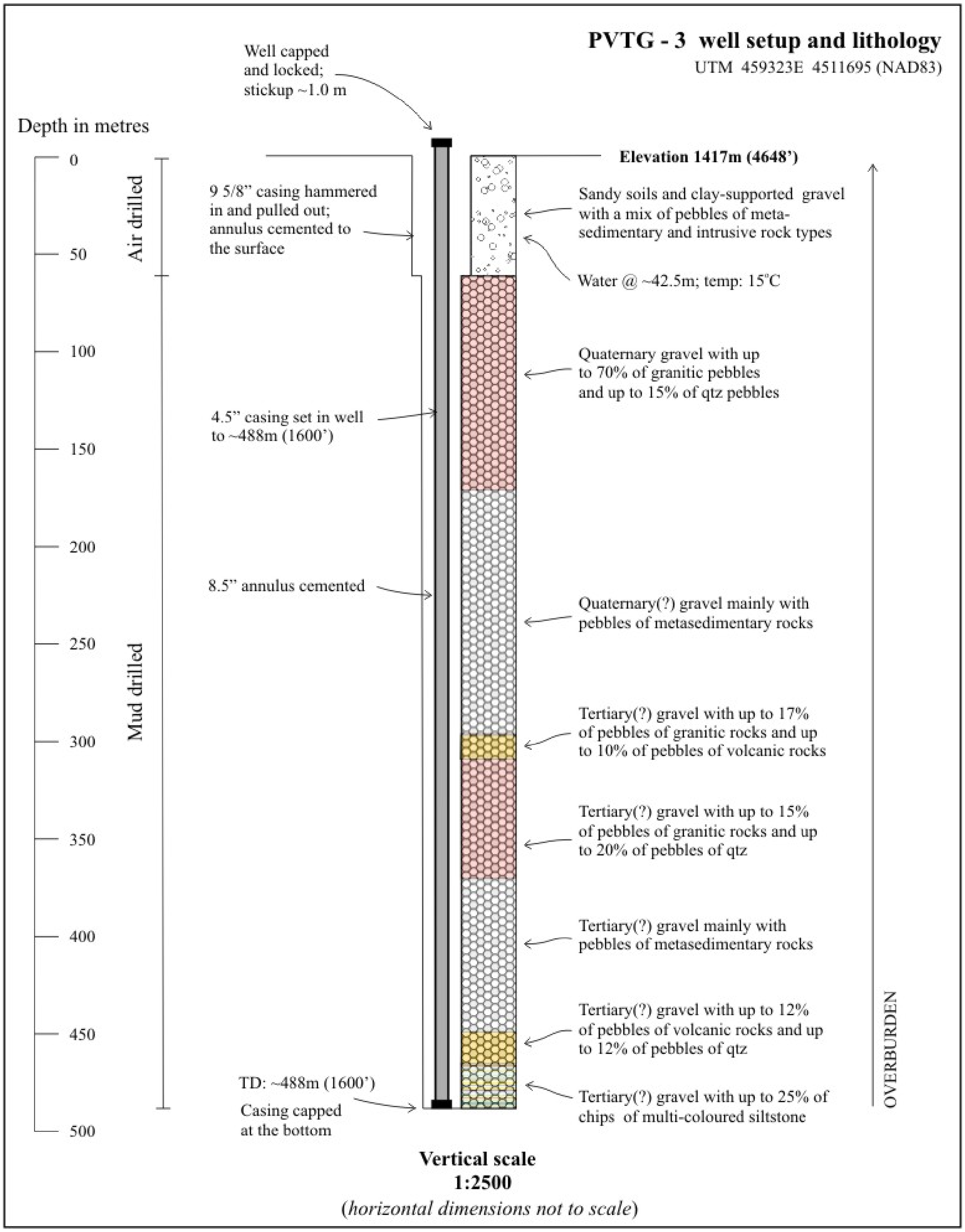

Figure 27. The PVTG-3 well setup and down-hole lithology.

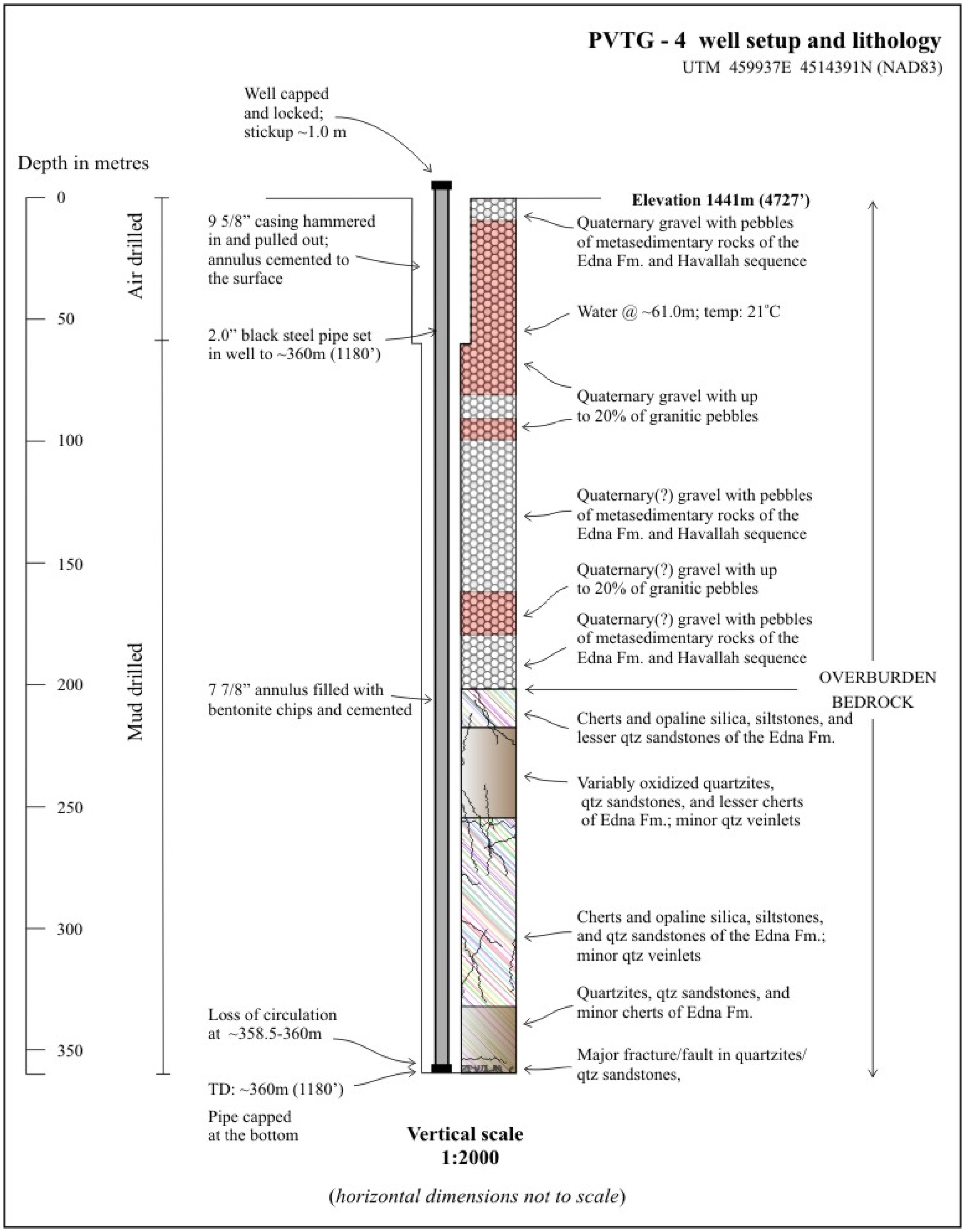

Figure 28. The PVTG-4 well setup and down-hole lithology.

Temperature data and gradients

All four wells drilled by Nevada Geothermal Power Company were successful in encountering geothermal fluids. The temperatures from the new temperature gradient holes (Figures 29-32 and Appendix B) and old exploration boreholes (Trexler, 1982) were obtained using calibrated thermistor probes having an accuracy of approximately 0.1°C. This data was used to calculate the shallow thermal gradients (Sadlier-Brown, 2004; and this work), which are in the range of less than 100° C/km to over 280° C/km (Table 1). However, the available data from the older drill holes, with the exception of the Magma well, is confined to depths less than 100m and the geothermal gradient calculated are shallower than those from the Magma and Nevada Geothermal wells.

The Hobo thermistor temperature recorded at the bottom of the PVTG-1 well was 46.4°C; in the PVTG-2 was 34.4°C and was reached at -305m; in the hole PVTG-3 the maximum temperature recorded at the bottom of the hole, at -488m, was 80.8°C; and of the PVTG-4 well was 45.5°C at -280m. The combined data from the old and recent wells appears to define a field of at least 2.0 by 4.0 km with thermal gradients of >100° C/km (Figure 33). The geothermal gradients in both the Magma and PVTG-3 holes increase, notably in their lower portions, to 160° C/km (Shevenell and Garside, 2003) and 169° C/km (this report), respectively.

Two generalized colour cross sections through the temperature gradient holes (PVTG) and old exploration boreholes clearly indicate the presence of a major plume of thermal water in the area defined by the wells E, F, and G (Figure 34) and centered on the Pumpernickel Valley fault. The contoured temperature data conform to the expected location of the fault system and indicates that the main plume is controlled, at least in part, by flow from this fault system. This same thermal expression, at a somewhat greater depth, is present within the area between the Magma well and thermal gradient holes PVTG-3 and PVTG-4. The geothermal system almost certainly continues beyond these holes and might be open to the east and south.

With the exception of the PVTG-4, none of the geothermal gradient holes show any indication that temperatures become isothermal or decrease with depth. In PVTG-4, at a depth of >270 meters in the cherts and quartzites of the Edna Fm., temperature values begin to taper off, but appear to reverse again after the hole strikes a major fault/fracture.

Clearly, the heat source responsible for the temperatures associated with the plume has not been intersected in any of the Nevada Geothermal Power Company holes and must be at a depth greater than 920 meters (depth of the deepest hole in the project area, the Magma well).

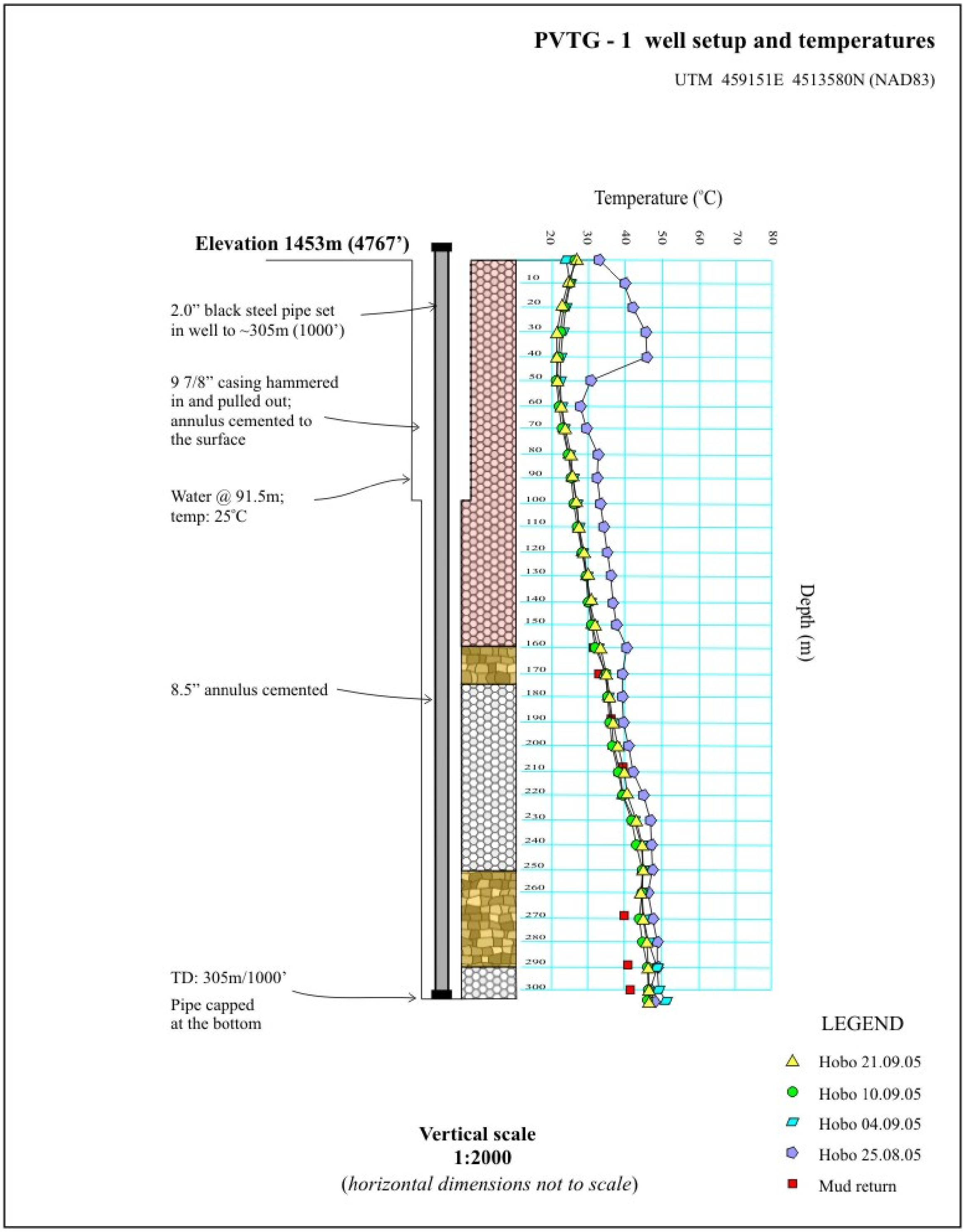

Figure 29. The PVTG-1 well setup and down-hole lithology vs.temperature profiles.

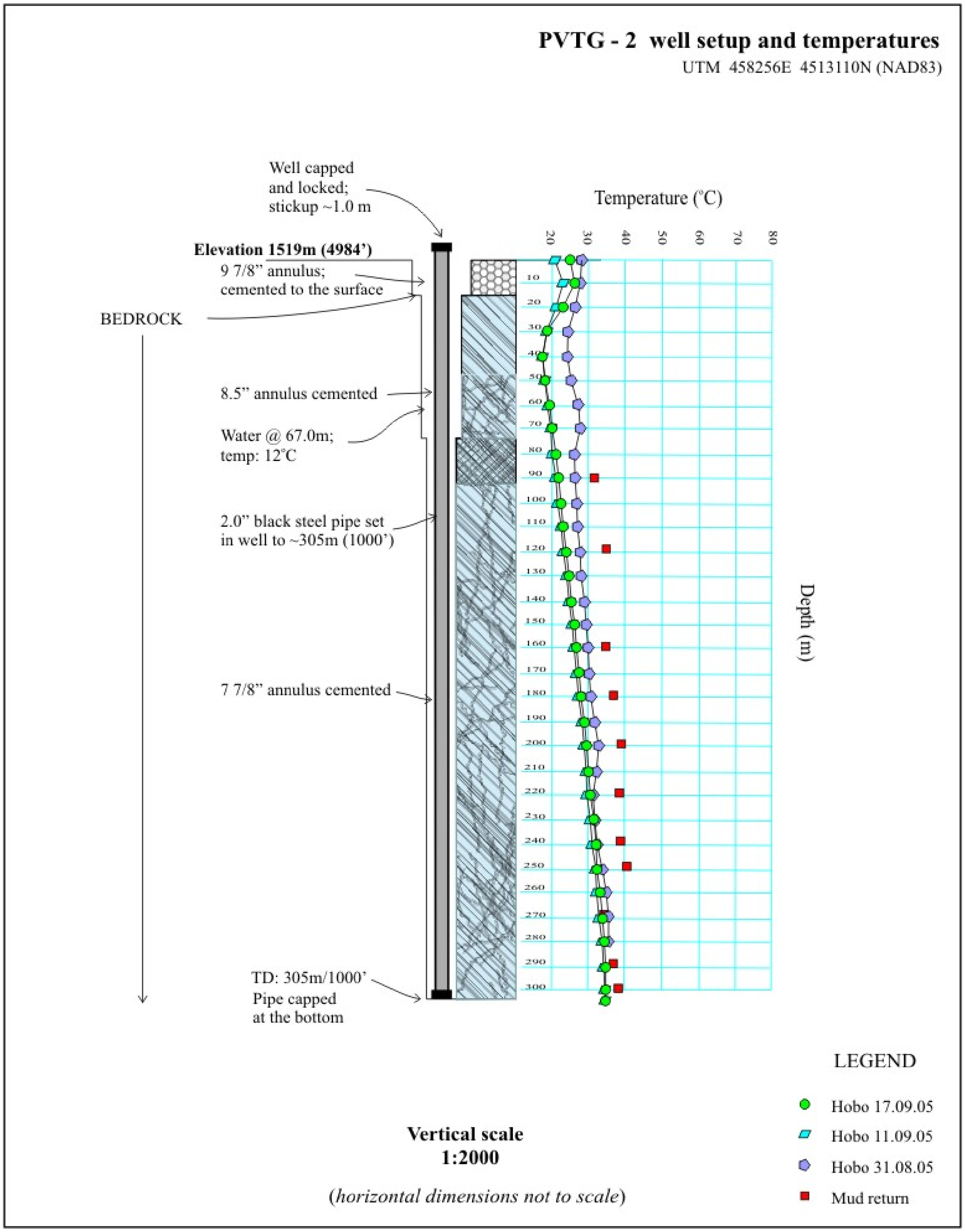

Figure 30. The PVTG-2 well setup and down-hole lithology vs.temperature profiles.

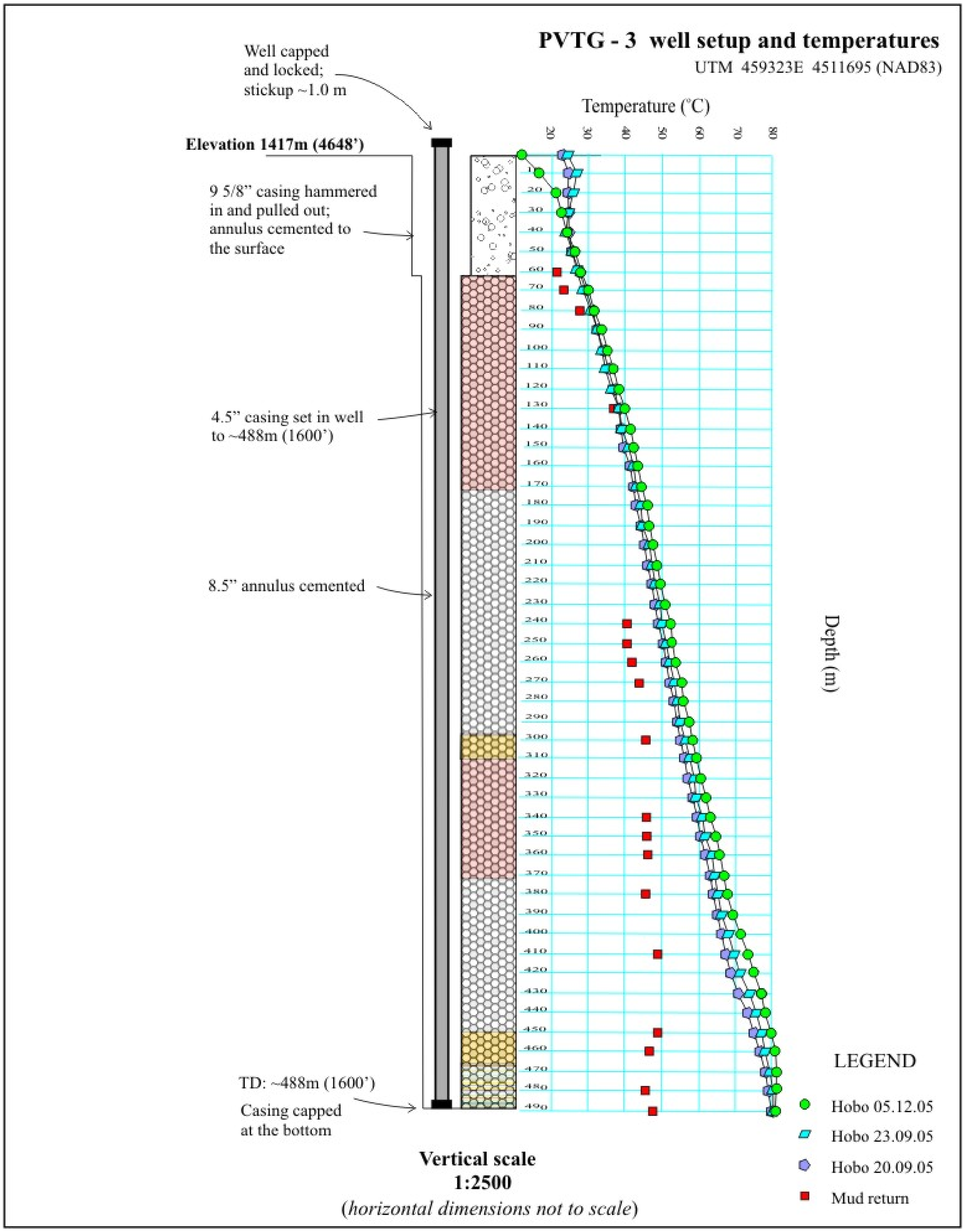

Figure 31. The PVTG-3 well setup and down-hole lithology vs.temperature profiles.

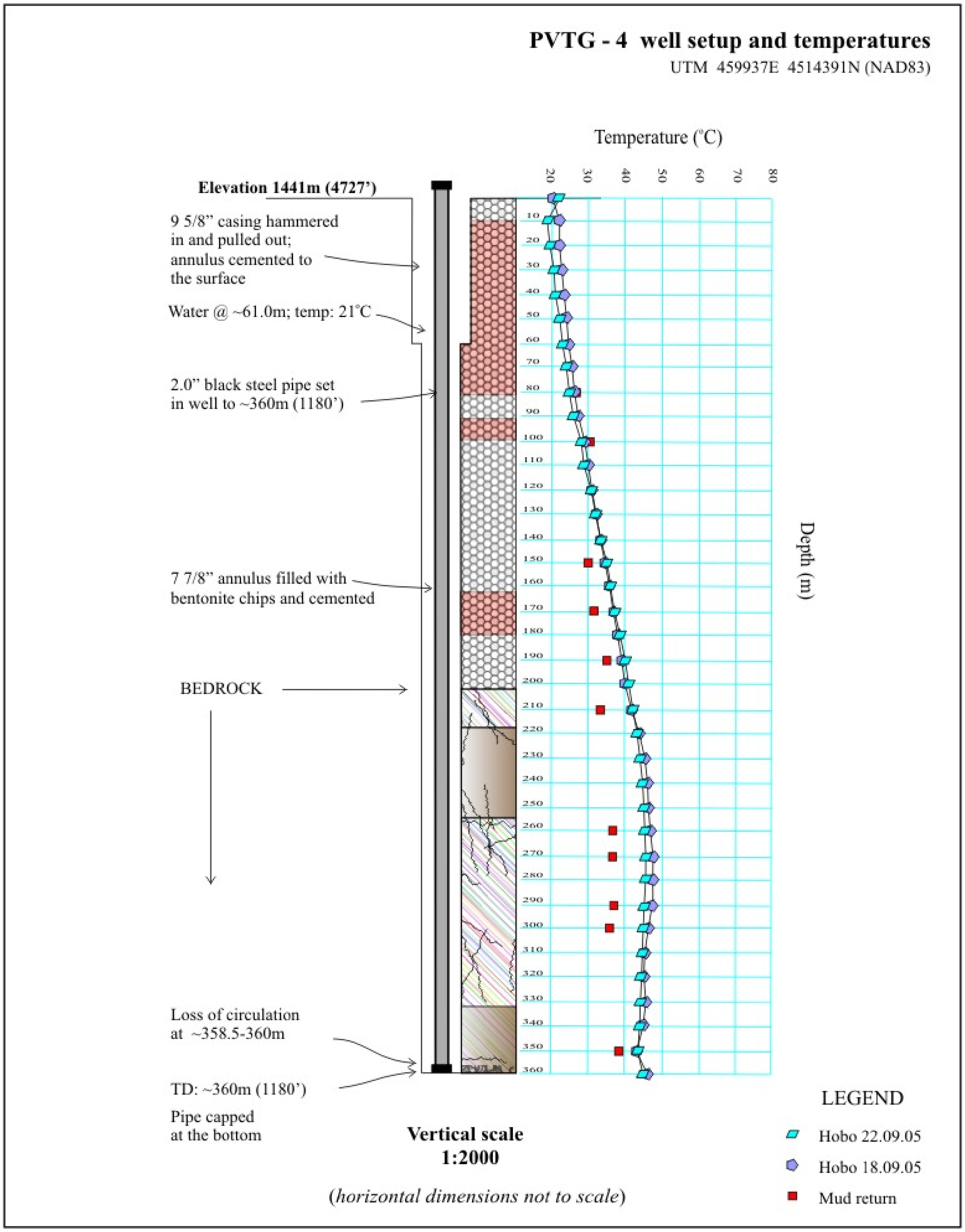

Figure 32. The PVTG-4 well setup and down-hole lithology vs.temperature profiles.

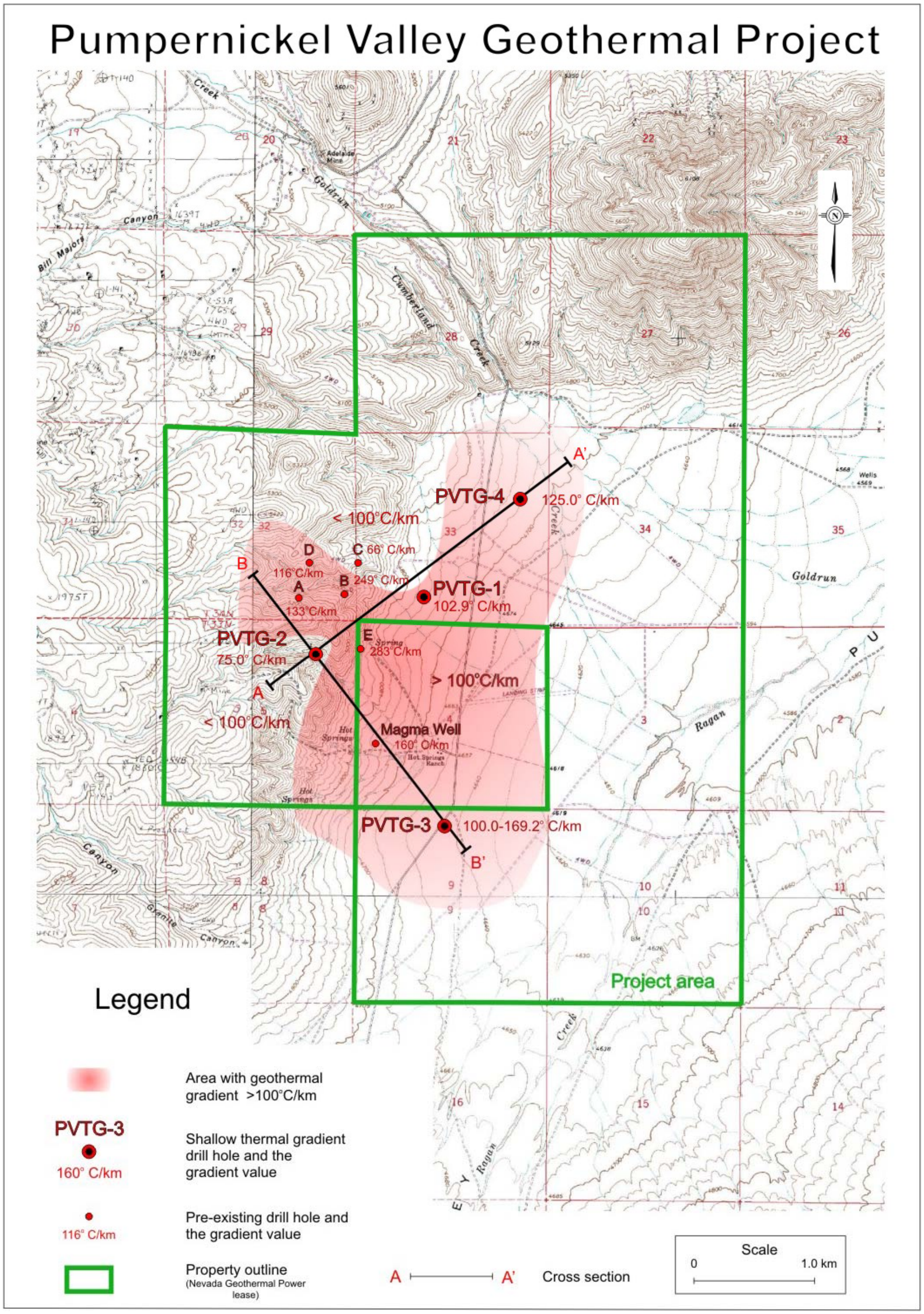

Figure 33. Pumpernickel Valley geothermal system – area with geothermal gradient >100^{o}C/km.

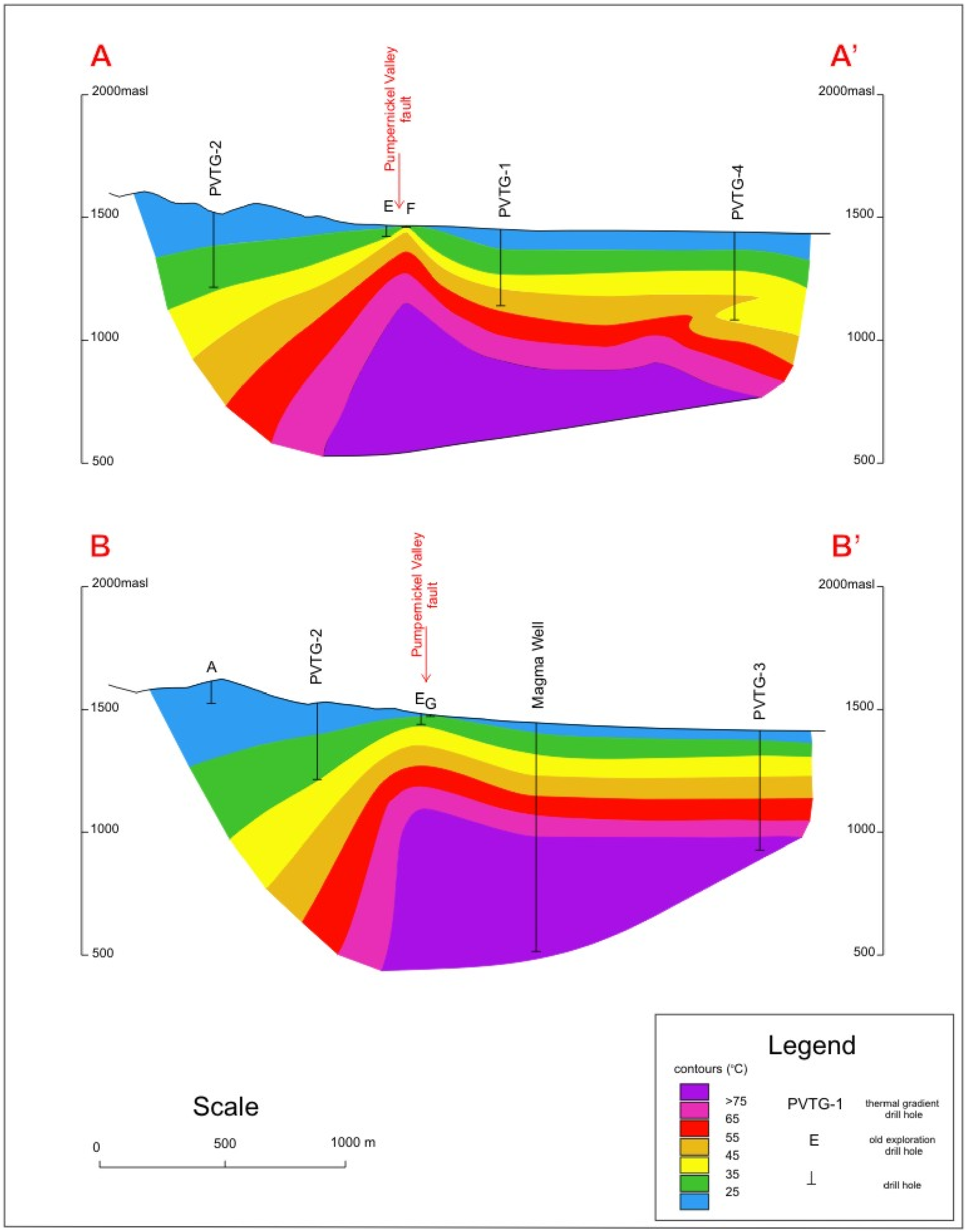

Figure 34. Pumpernickel Valley geothermal system; generalized temperature cross sections A-A' and B-B' based on the well data and extrapolated at depth. For the cross section locations see Figure 33.

Geochemistry

The brine from the drill holes, hot springs, seepages, and irrigation wells was sampled, as well as water from two nearby creeks, (total of 13 samples) and sent for analysis to Thermochem Inc. For sample locations refer to Figure 35; the geochemical data are presented in Appendix C.

Geochemical results indicate the presence of two distinct waters in this group of samples (Tom Powell of Thermochem Inc., personal communication, 2005). Powell found that MDH, TRS-1 and TRS-6 are the most prospective waters and tend to be more bicarbonate rich with much higher proportions of B, Li and much lower Cl. They are clearly related, and all have the same Cl concentration but vary in the other constituents.

Table 1. Geochemical Geothermometers (calculated by Tom Powell of Thermochem Inc.). Samples PVTG-1 to -4 are from the geothermal gradient holes; MDH is from the Magma well; TRS-1 and TRS-6 are from hot springs; TRS-5 is a fresh water seepage; BB2 and BB4 are from irrigation wells; PVS-2 from the Goldrun Creek; PVS-4 from a cold spring; and PVS-5 from a creek.

Sample Name	T Chalce-dony	T Quartz cond.	T Na-K-Ca	T Na-K-Ca Mg corr.	T Na/K (Giggen-bach)	T K/Mg (Giggen-bach)	T Anhydrite
PVTG-1	40	73	147	69	205	60	120
PVTG-2	43	76	168	78	265	58	120
PVTG-3	35	67	108	65	132	51	136
PVTG-4	22	54	158	113	206	83	169
MDH	139	163	175	145	220	105	167
TRS-1	134	159	185	168	219	122	195
TRS-6	103	131	179	109	233	94	145
TRS-5	49	81	141	64	222	42	99
BB2	48	80	131	64	201	40	155
BB4	51	83	128	69	191	42	142
PVS-2	42	74	122	54	178	39	135
PVS-4	27	59	148	80	238	46	121
PVS-5	61	93	166	54	247	59	215

Powell also concluded that the “best water” is TRS-1 (from the spring located near the Pumpernickel Valley fault). “Low temperature geothermometers (K-Mg, chalcedony) range from 120^{o} C (K-Mg) to 140^{o} C (chalcedony). Na/K trends to 220^{o} C, suggesting that the source water may achieve this temperature and then pick up Mg and Ca on its way to the surface. High Mg is a characteristic of bicarbonate waters, perhaps because they are mildly acidic and would tend to dissolve local rocks. This would drive the K-Mg geothermometer down and might make the waters look cooler than the actual source. The trend of the 3 waters suggests that they have picked up Ca and SO4 on their way to the surface, lowering the anhydrite geothermometer for the TRS-6 water. This might be expected in arid valley fill, with evaporite gypsum present.”

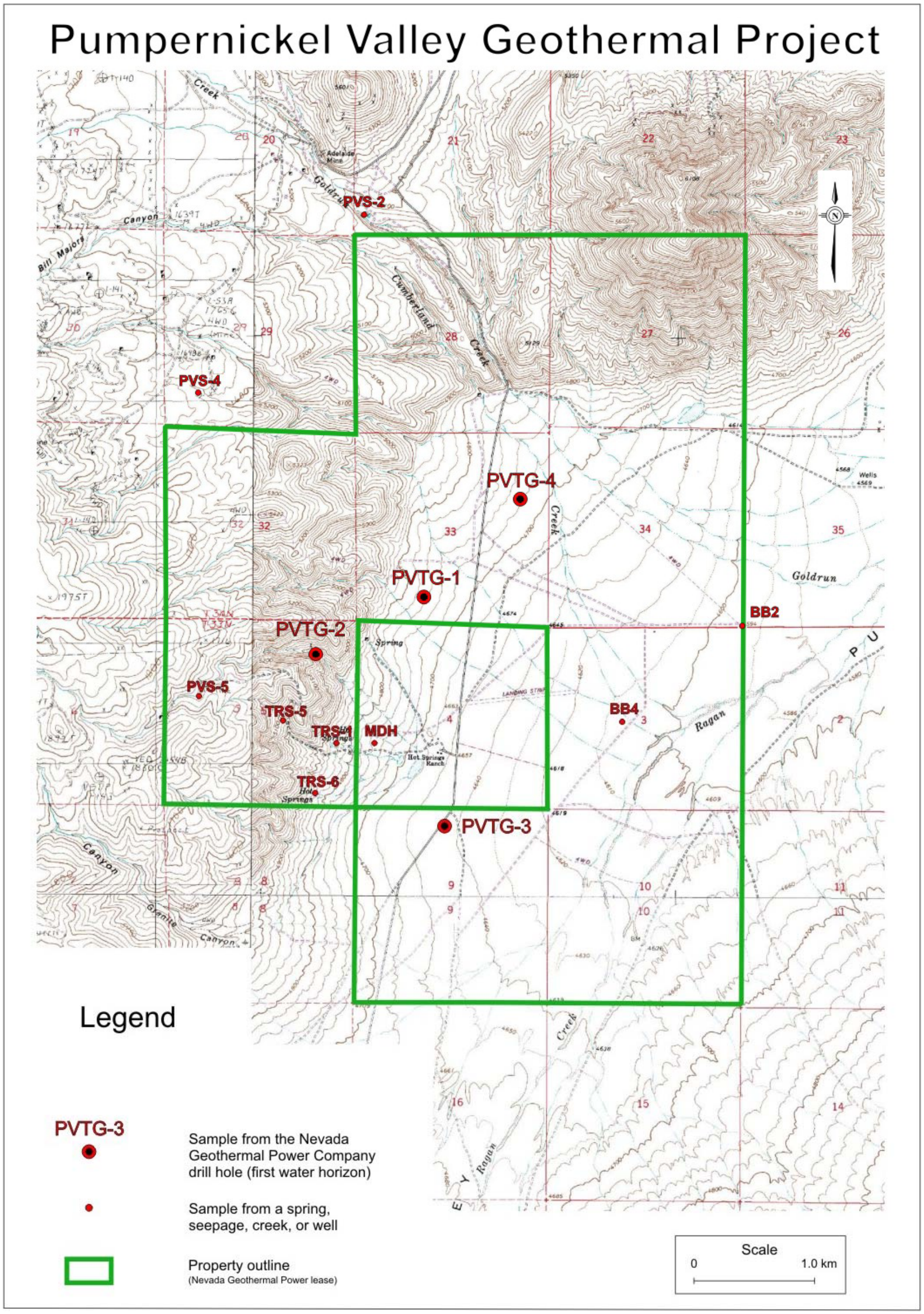

Figure 35. Location of water samples collected in the project area.

"The higher temperature waters may be related to a limestone aquifer. The Cl/B/Li ratios are about right (see the data table in Appendix C), they are saturated with respect to calcite (see Xkmc) and show an Mg/Ca ratio slightly below that of limestone (see the Xnckm chart in Appendix C). The lower Mg would be presumably due to uptake by clays at moderate temperature.

Powell concluded that "The other waters roughly follow a gypsum dissolution trend". "They appear to mostly be in the family of the chloride-bearing, low boron, low silica (and apparently low temperature) waters and the low chloride bicarbonate rich waters that showed higher geothermometer temperatures. The low temperature chloride-bearing, low B waters are probably shallow to moderate depth basin waters that don't appear to have ever been above about 60^{o}C."

The above conclusion has been confirmed by Jill R. Haizlip of Geologica (personal communication, 2005), who also calculated chemical geothermometers and prepared plots (Appendix C) of the results for the water samples from the thermal gradient holes in order to evaluate the presence of geothermal fluids in the samples. "The low temperature geothermometers (silica and Na-Mg) generally suggest temperatures in the range of 70 ± 20 ^{o}C (primarily based on silica geothermometers)". "These waters can be characterized as bicarbonate, with some sodium-potassium bicarbonate and some calcium bicarbonate groundwaters. Samples from PVTG-3 and PVTG-4 have similar cation chemistry to TRS-1, the "most prospective" water identified in a previous data review (Tom Powell, see above). In addition, the PVTG-3 sample has high bicarbonate like the results from analysis of samples from the spring TRS-1".

Haizlip stated that the "boron/chloride analytical results suggest that these waters are not related by mixing to the warmer waters (TRS-1, TRS-6 and MDH) previously identified, and the silica contents are not nearly as high. These results suggest that the sampled waters do not have a direct relationship with the warm waters previously sampled and analyzed within the valley", "however, they appear to be from a similar albeit cooler geochemical environment".

Yet, the reasoning of Powell and Haizlip is not supported by the field observations, which suggest that there is a considerable amount of fluid mixing within the geothermal system. First, all water samples collected from the geothermal gradient wells (PVTG-1 to -4) represent the upper-most water horizons, which most certainly contain a component of the meteoric and/or ground waters. Second, cold spring and seepages occupy the same area along the fault with the hot springs (refer to the chapter on Geothermal features) and indicate that they all utilize the same fault/fracture system. Third, there is an observable case of fluid mixing in the southern set of hot springs, where water from a hot spring (TRS-6) flows within a short distance into a cold spring, from which the mixed fluid flows as a ~300m long creek into the valley and disappears within the valley floor. The same applies to the northern swarm of hot springs and the Magma well, from which brine actively leaks into the overburden. And fourth, the two water samples, PVS-2 and PVS-5, taken from the creeks located west and northwest, respectively, of the project area and flowing into the valley, already contain a geothermal fluid component.

Some rather unusual geochemical characteristics have also been noted during the previous surveys of waters in the Tipton Ranch hot springs. Wollenberg (1974; *in* Garside and Schilling, 1979) reported that slightly anomalous radioactivity (up to 22.5 µR/hr) is present at the springs. In addition, water from the springs and condensate from the Magma well contain elevated quantities of antimony and tungsten, both significantly higher than any other hot springs sampled in the western USA (Erdman et al., 1991).

Anomalously high concentrations of radon and mercury were found by the staff of Fairbank Engineering Ltd. in soils near the active hot springs (Hantelmann, 2005), although there seems to be a lack of obvious correlation between the anomalies and nearby geological features, like the Pumpernickel Valley fault.

Setting of the Pumpernickel Valley geothermal system

The Pumpernickel Valley project area shows a strong similarity to pull-apart structures, which form in 3-D in the stepover or in a releasing bend of the strike-slip system. The immediate zones of the Pumpernickel Valley and Edna Mountain faults display many characteristics typical of strike-slip fault systems, including some rotational deformation, superposition of structures, lens-shaped push-up structures, and local en echelon arrangement of high-angle faults.

The overall pattern of the low resistivity anomaly in the valley, represented by a complex rhomb- and/or trapezoid-shaped area bounded by two sets of approximately NNE-trending and NNW-trending faults (Figure 18), is also indicative of a releasing stepover or pull-apart basin. The western low resistivity anomaly is marked by a major NNE break in the slope associated with the Pumpernickel Valley fault, whereas at the northern end, the stepover is delimited by the approximately northwest-trending set of buried structures and the approximately west-trending Edna Mountain fault.

The two highly conductive areas, A and B-C in Figure 18 are interpreted here as subsidence centers of the pull-apart basin. The numerous en echelon linear features most likely represent extensional fans of fault-bounded blocks arranged in a stepping-down fashion. The smaller resistivity-low anomalies delineated by Shore (2005) west of the Pumpernickel Valley fault may also represent in part actively forming, smaller scale pull-apart features.

Two clusters of hot springs and one fossil spring are spatially associated with sections of the Pumpernickel Valley fault (Figure 14). There is a significant amount of fluid flow from the hot springs near the Pumpernickel Valley fault directly into the valley fill. This geothermal fluid saturates the valley fill and possibly accumulates near the contact between the overburden and the basement, and emphasizes the resistivity characteristics of the fill and the structure of the basin.

The widespread hydration and alteration around the Pumpernickel Valley fault, most likely reflect the fluid up-flow. The nearby, down dropped structural blocks may define the immediate reservoir, as suggested by the Magma hole, in which the temperature and geothermal gradient started to increase in the last 90 meters of the 919.6m hole. Similar distribution of temperatures in the PVTG-3 well (Figure 34) suggests that this reservoir extends east and south of the Magma well. Clearly, the heat source responsible for the temperatures associated with this plume has not been intersected and must be at a depth greater than 920 meters (the maximum depth of the Magma well).

Model for the Pumpernickel Valley geothermal field

The overall geological and structural setting and other characteristics of the Pumpernickel Valley area are strikingly similar to parts of the nearby Dixie Valley geothermal field (Figure 36). Dixie Valley represents an active Basin and Range-type graben and lies just 80 km SW from the Pumpernickel Valley project area, along the strike of the main structures in west-central Nevada.

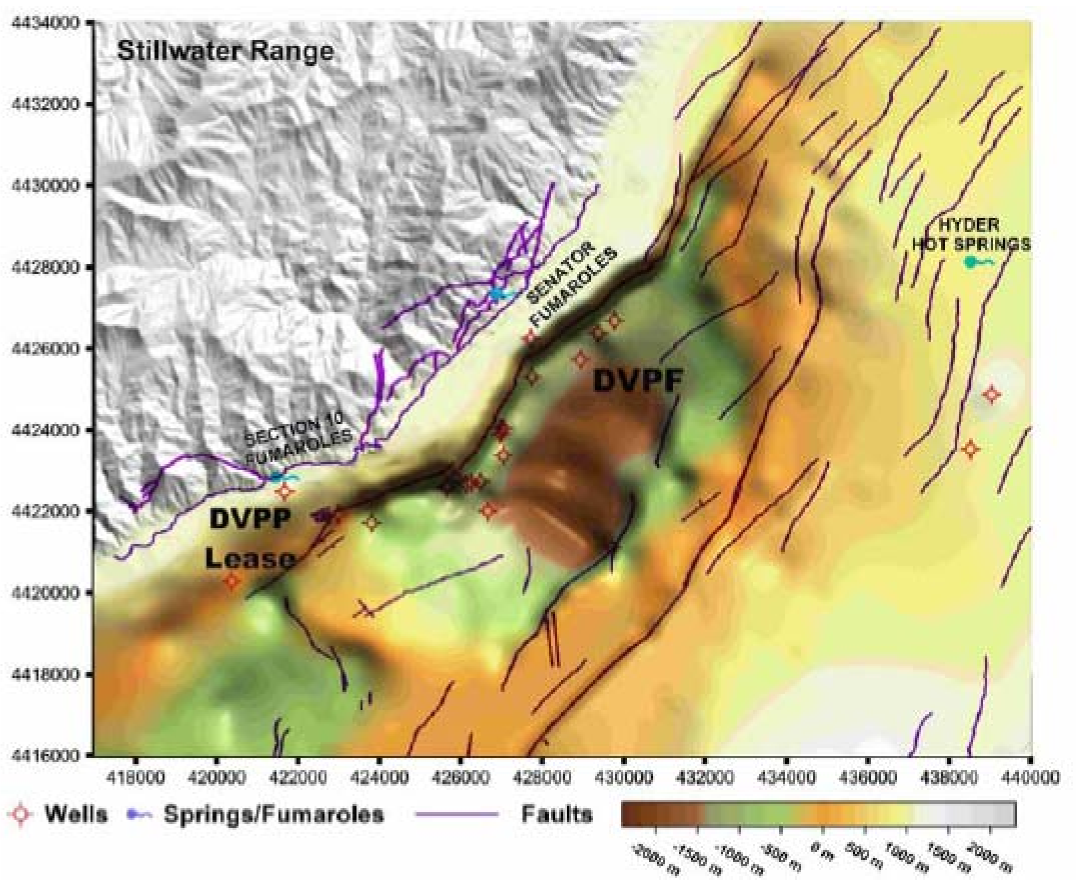

Figure 36. Dixie Valley well locations, mapped faults, and basin depth from McKenna et al. (2005).

The Dixie Valley system is a complex zone of deformation, rather than a simple planar surface (Blackwell et al., 2000; Smith et al., 2002; Johnson and Hulen, 2002; and

McKenna et al., 2005). There are numerous Quaternary/Holocene faults in the valley whose scarps are not visible on the surface in the field, but are evidenced by the seismic reflection profiles, high-resolution aeromagnetic surveys, and detailed air photo interpretation(e.g. Blackwell, et al., 2002; Smith et al., 2002; Grauch, 2002).

The presently producing geothermal reservoir lies along a steeply dipping, multiple fault system (Blackwell et al., 2002; McKenna et al., 2005). The reservoir is made up of an unknown number of fault strands and only a few of these have been penetrated by wells. The geothermal fluid flows upward along this complex normal fault zone (Blackwell et al., 2000) and there is a significant fluid loss in the geothermal system via leakage from the piedmont faults directly into the valley fill (McKenna et al., 2005).

The reservoir, at least 5 km long and 2 km wide, has temperatures of 225 to 245°C at depths near 2500 m and over 265°C below 3000m (Blackwell et al., 2000; McKenna et al., 2005). The position of the highest reservoir temperatures is almost directly below the range front at a depth of about 3 km. It has been found that the fractures feeding the geothermal field in the upper 4 km of the crust are steeper than 75°.

The Dixie Valley geothermal field has a rated output of 62 MW and has been producing electrical power for Oxbow Geothermal Corp. since 1988 and for Caithness Operating Co. since 2000 (Blackwell et al., 2000).

Conclusions

The Pumpernickel Valley geothermal project area is located near the eastern edge of the Sonoma Range and is positioned within the structurally complex Winnemucca fold and thrust belt of north-central Nevada. A series of approximately north-northeast-striking faults related to the Basin and Range tectonics are superimposed on the earlier structures within the project area, and are responsible for the final overall geometry and distribution of the pre-existing structural features on the property.

Two of these faults, the Pumpernickel Valley fault and Edna Mountain fault, are range-bounding and display numerous characteristics, such as rotational deformation, superposition of structures, lens-shaped push-up features, local en echelon arrangement of high-angle faults, and the lithostratigraphic repetition, typical of strike-slip fault systems. These characteristics, when combined with geophysical data from Shore (2005), indicate the presence of a pull-apart basin, formed within the releasing bend of the Pumpernickel Valley – Edna Mountain fault system.

A substantial body of evidence exists, in the form of available geothermal, geological and geophysical information, to suggest that the property hosts a structurally controlled, extensive geothermal field. The most evident manifestations of the geothermal activity in the valley are two areas with hot springs, seepages, and wet ground/vegetation anomalies near the Pumpernickel Valley fault, which indicate that the fault focuses the fluid up-flow.

Magma Power Company drilled one exploration/temperature gradient borehole east of the Pumpernickel Valley fault and recorded a thermal gradient of 160°C/km. The temperature data from five mineral exploration holes to the north of the Magma well indicated geothermal gradients in a range from 66 to 249°C/km for wells west of the fault, and ~283°C/km in a well next to the fault.

Nevada Geothermal Power Company drilled four geothermal gradient wells, PVTG-1, -2, -3, and -4, and all four encountered geothermal fluids. The holes provided valuable water geochemistry, supporting the geothermometry results obtained earlier from the hot springs and Magma well (Szybinski, 2005). The deepest hole, PVTG-3 never reached bedrock and the 4.5" casing was cemented back to the surface so that it could be deepened at a later date. In the other three holes, the 2" tubing has been cemented back to the surface.

The temperature data gathered from all the wells clearly indicates the presence of a major plume of thermal water centered on the Pumpernickel Valley fault, and suggests that the main plume is controlled, at least in part, by flow from this fault system. It also defines the geothermal resource with gradients >100°C/km, which covers an area a minimum of 8 km^2. Structural blocks, down dropped with respect to the Pumpernickel Valley fault, may define an immediate reservoir. The geothermal system almost certainly continues beyond the recently drilled holes and might be open to the east and south, whereas the heat source responsible for the temperatures associated with this plume has not been intersected and must be at a depth greater than 920 meters (depth of the deepest well – Magma well).

The geological and structural setting and other characteristics of the Pumpernickel Valley geothermal project area are markedly similar to the portions of the nearby Dixie Valley geothermal field. These similarities include, among others, the numerous, unexposed en echelon faults and large-scale pull-apart structure, which in Dixie Valley may host part of the geothermal field.

The project area, for the majority of which Nevada Geothermal Power Company has geothermal rights, represents a geothermal site with a potential for the discovery of a relatively high temperature reservoir suitable for electric power production. Among locations not previously identified as having high geothermal potential, Pumpernickel Valley has been ranked as one of four sites with the highest potential for electrical power production in Nevada (Shevenell and Garside, 2003).

Richards and Blackwell (2002) estimated the total heat loss and the preliminary production capacity for the entire Pumpernickel Valley geothermal system to be at 35MW. A more conservative estimate, for the hot spring area only, was presented by GeothermEx Inc. (2004), which projected that power generation capacities for the Pumpernickel Valley site are 10 MW-30yrs minimum (probablility of >90%), and most likely 13 MW-30yrs.

Recommendations

Notwithstanding the results of the completed shallow thermal gradient drilling program within the project area, which intersected geothermal fluids mainly within the valley fill (with an exception of PVTG-4), there should a minimum of two deep (>1000m) holes drilled above the Pumpernickel Valley fault in a step-out fashion. There are field indications that this fault, dominated by a steep dip (>75^o), is the major geothermal feeder. The fault might be equally steep at depth, thus it will be more effective, technically and cost wise, to use deviated drilling to increase the prospect of intersecting such a steeply dipping structure.

Borehole PVTG-3, located directly within the main low resistivity anomaly defined by Shore (2005), should be deepened and an attempt should be made to intersect the heat source associated with the geothermal plume. The line between PVTG-3 and PVTG-4, and especially in the immediate area of the low resistivity anomaly "A" (*op cit*), should be targeted by another deeper hole and drilled into the bedrock. The resistivity survey (*op cit*) indicates that possible structures in the bedrock(?), located in the vicinity of this line, may feed the geothermal system as well.

Further drilling and exploration of the Pumpernickel Valley geothermal project area should be combined with a gravity or seismic geophysical survey. The main objective of either survey will be to depict the contact between the valley fill and the basement rocks. In addition further information will be gathered on the valley faults and their relationship to the geothermal system (i.e. defining the boundaries of the geothermal reservoir).

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Appendix A

Statement of Qualifications

I, Z. Adam Szybinski, do hereby certify that:

1. I am a geologist with Fairbank Engineering Ltd, with offices at suite 900, 409 Granville Street, Vancouver, BC, Canada, V6C 1T2.

2. I graduated with a M.S. degree in geology from the University of Wroclaw (Breslau), Poland, in 1975, and obtained a Ph.D. degree (1996) in Earth Sciences from Memorial University of Newfoundland, NL, Canada.

3. I have worked as geologist in mineral exploration, academia, and geological surveys since 1975, in Canada, United States, Peru, Mongolia, and Poland. My work has included examination and reporting on a broad spectrum of geological settings, together with detailed geological investigation of mineral districts, producing mines, and geothermal properties

4. I have no interest in the Pumpernickel Valley property and do not hold any interest in Nevada Geothermal Power Inc./Nevada Geothermal Power Company or in Inovision Solutions Inc.

5. I have authored this report based on the mapping, and sampling of hot springs and chips from the drill holes at the Pumpernickel Valley property, and upon the review of regional geological studies, as well as scientific papers published in recognized journals.

6. I have conducted this report under a contract with Nevada Geothermal Power Inc./ Nevada Geothermal Power Company and Mr. Brian Fairbank, P.Eng., Fairbank Engineering Ltd.

Signed and dated in Vancouver, B.C., January 09, 2006.

Z. Adam Szybinski, *Ph.D.*

Appendix B

Chip logs
from the shallow thermal gradient drill holes
in the Pumpernickel Valley
geothermal project area

Drill holes:

PVTG-1
PVTG-2
PVTG-3
PVTG-4

Drill hole:

PVTG-1

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Mud Log

PROJECT: Pumpernickel Valley
HOLE NO.: PVTG-1
LOCATION: Pumpernickel Vly, Humboldt Co.
COORDINATES: 459151 E, 4513580 N. NAD 83
ELEV: 4767' AZIMUTH: DIP: 90°
SECTION: 33 T 34N R 40E
DATE: 18.8-24.8, 2005
LOGGED BY: Adam Szybinski
CONTRACTOR: WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intrusive %	Volcanics %	Qtz %
From	To	1	2	Angular	Rounded	Range	Class					
0	10	GY	PK	A	SR	<15mm	MG	metaseds - Preble Fm.: mudstone,chert, quartzite, qtz schist, phyllite	~96	2		2
10	20	GY	PK	SA	SR	<15mm	MG	metaseds - Preble Fm.	~100			
20	30	GY	BG	SA	SR	<22mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	5		10
30	40	GY	BG	SA	SR	<20mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~80	15		5
40	50	GY	BG	SA	SR	<25mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~82	8		10
50	60	GY	BG	SA	SR	<19mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	5		10
60	70	GY	BG	SA	SR	<21mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	5		10
70	80	GY	BG	SA	SR	<17mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~90	5		<5
80	90	GY	PK	SA	SR	<10mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~82	15		~3
90	100	GY	DK	SA	R	<20mm	CG	metaseds - Preble Fm.	~100			
100	110	GY	PK	SA	R	<9mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	10		~3
110	120	PK	GY	SA	SR	<6mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~77	25		8
120	130	GY	LT	SA	SR	<15mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~90	<5		5
130	140	GY	LT	SA	SR	<10mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	10		5
140	150	GY	PK	SA	SR	<15mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~75	10		15
150	160	GY	BG	SA	R	<8mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~90	5		<5
160	170	GY	BG	SA	SR	<13mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~88	10		~2
170	180	GY	BG	SA	SR	<8mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	10		<5
180	190	GY			SR/R	<15mm	MG	metaseds - Preble Fm.	~100			
190	200	GY	BG		SR/R	<18mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~92	5		<3
200	210	GY	DK	A	SR	<20mm	CG	metaseds - Preble Fm.	~100			
210	220	GY	BG	A	SR	<13mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~80	15		5
220	230	GY	PK	A	SR	<10mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	15		3
230	240	GY	BG	SA	SR	<11mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~92	5		3
240	250	GY	BG	SA	R	<17mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	10		5
250	260	GY	BG	A	SR	<15mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~83	12		5
260	270	PK	GY	A	SR	<18mm	CG	metaseds - Preble Fm., adds of fels intrusives	~87	13		
270	280	PK	GY	SA	SR	<19mm	CG	metaseds - Preble Fm., adds of fels intrusives	~85	15		
280	290	PK	GY	A	SR	<14mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~82	15		3
290	300	GY	BG	A	SR	<19mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~90	5		5
300	310	GY	BG	SA	SR	<17mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~87	8		5
310	320	GY	BN	SA	SR	<11mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	10		5
320	330	GY	PK	A	SR	<7mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~60	30		10
330	340	GY	PK	A	R	<15mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~65	25		10
340	350	GY	BG	A	SR	<10mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~82	10		8
350	360	GY	BG	A	SR	<7mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~70	15		15
360	370	GY	RD	A	SR	<8mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~73	15		12
370	380	GY	RD	A	SR	<8mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~74	16		8

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459151 E, 4513580 N.	NAD	83	DATE:	18.8-24.8, 2005
HOLE NO.	PVTG-1	ELEV	4767'	AZIMUTH		DIP	90^{o}
						LOGGED BY:	Adam Szybinski
LOCATION	Pumpernickel Vly, Humboldt Co.	SECTION	33	T 34N	R 40E	CONTRACTOR:	WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intrusive %	Volcanics %	Qtz %
From	To	1	2	Angular	Rounded	Range	Class					
380	390	GY	RD	A	SR	<8mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~82	10		8
390	400	GY	BG	A	SR	<10mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~80	15		5
400	410	GY	BG	SA	SR	<8mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~70	20		10
410	420	GY	RD	SA	SR	<15mm	CG	metaseds - Preble Fm., adds of fels intrusives and qtz	~82	10		8
420	430	GY	RD	SA	SR	<12mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	>90	<5		<5
430	440	GY	PK	A	SR	<12mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~78	15		7
440	450	GY	PK	SA	SR	<10mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	>90	5		<5
450	460	GY	BN	A	R	<9mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~85	7		8
460	470	GY	PK	A	SR	<6mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~78	12		10
470	480	GY	BG	SA	SR	<10mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~88	10		8
480	490	GY	BG	SA	R	<9mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~87	5		8
490	500	PK	BG	A	SR	<13mm	MG	metaseds - Preble Fm., adds of fels intrusives and qtz	~80	12		8
500	510	GY	BG	SA	SR	<8mm	FG	metaseds - Preble Fm., adds of fels intrusives and qtz	~79	12		9
510	520	GY	BG	SA	SR	<7mm	FG	metaseds - Preble Fm., adds of fels intrusives, volcs, qtz	~85	<5	8	10
520	530	PK	GY	A/SA		<13mm	MG	Tertiary volcs, metaseds of Preble Fm., felsic intrusives, qtz	~38	8	~50	4
530	540	PK	GY	A/SA		<11mm	MG	metaseds of Preble Fm., adds of Tertiary volcs, fels intrusives, qtz	~65	5	~25	5
540	550							no sample				
550	560	GY	BG	A/SA		<12mm	MG	Tertiary volcs, adds of metaseds, fels intrusives, qtz	17	3	~80	
560	570	GY	BG	A/SA		<12mm	MG	Tertiary volcs, adds of metaseds, fels intrusives, qtz	<3	2	>95	
570	580	GY	BG	A	SR	<11mm	MG	metaseds - Preble Fm., adds of fels intrusives, volcs, qtz	~85	5	5	5
580	590	GY	BG	A/SA		<14mm	MG	metaseds of Preble Fm., adds of Tertiary volcs, fels intrusives, qtz	~62	5	25	8
590	600	GY	BG	A/SA		<11mm	MG	metaseds of Preble Fm., adds of Tertiary volcs, fels intrusives, qtz	>75	<5	15	<5
600	610							no sample				
610	620	GY	PK	A/SA		<7mm	FG	metaseds - Preble Fm., adds of qtz	~95			5
620	630	GY	PK	A	SR	<8mm	FG	metaseds - Preble Fm., adds of fels intrusives, volcs, qtz	~92		8	
630	640	GY	PK	A	SR	<13mm	MG	metaseds - Preble Fm., adds of fels intrusives, volcs, qtz	~92		5	3
640	650	GY	PK	A	SR	<6mm	FG	metaseds - Preble Fm., adds of fels intrusives, volcs, qtz	~90	7	3	
650	660	GY	OL	A	SR	<10mm	MG	metaseds - Preble Fm., adds of fels intrusives	~97	3		
660	670	GY	BG	A	SR	<8mm	FG	metaseds - Preble Fm., adds of fels intrusives	>97	<3		
670	680	GY	BG	A	SR	<8mm	FG	metaseds - Preble Fm.	~100			
680	690	GY	BG	SA	SR	<7mm	CG	metaseds - Preble Fm., adds of fels intrusives	~95	5		
690	700	GY	BG	A	SR	<8mm	FG	metaseds - Preble Fm., minor volcs	~99		1	
700	710	GY	BG	A	SR	<8mm	FG	metaseds - Preble Fm., minor volcs	~99		1	
710	720							poor sample				
720	730	GY	BG	A	SR	<6mm	FG	metaseds - Preble Fm.	~100			
730	740	GY	BG	SA	R	<7mm	FG	metaseds - Preble Fm.	~100			
740	750	GY	BG	A	SR	<7mm	FG	metaseds - Preble Fm., minor volcs	~98		1-2	
750	760	GY	BG	A	SR	<8mm	FG	metaseds - Preble Fm.	~100			

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459151 E,	4513580 N.	NAD 83	DATE:	18.8-24.8, 2005
HOLE NO.	PVTG-1	ELEV 4767'	AZIMUTH	DIP 90^o		LOGGED BY:	Adam Szybinski
LOCATION	Pumpernickel Vly, Humboldt Co.	SECTION 33	T 34N	R 40E		CONTRACTOR:	WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intrusive %	Volcanics %	Qtz %
From	To	1	2	Angular	Rounded	Range	Class					
760	770	GY	BG	A	R	<4.5mm	VFG	metaseds - Preble Fm.	~100			
770	780	GY	BG	SA	R	<7mm	FG	metaseds - Preble Fm.	~100			
780	790	GY	BG	A	SR	<9mm	MG	metaseds - Preble Fm.	~100			
790	800	GY	RD	A	SR	<7mm	FG	metaseds - Preble Fm.	~100			
800	810	GY	PK	SA	SR	<9mm	MG	Tertiary ash-flow tuffs, metaseds of Preble Fm., adds of qtz	~40		~40	~20
810	820	PK		A	SR	<10mm	chips	Tertiary ash-flow tuffs			100	
820	830	PK		A	SR	<12mm	MG	Tertiary ash-flow tuffs, adds of metaseds of Preble Fm.	20		~80	
830	840	PK		A	SR	<11mm	chips	Tertiary ash-flow tuffs, adds of metaseds of Preble Fm.	5		~95	
840	850	PK	BN	A	SR	<16mm	MG	Tertiary ash-flow tuffs, adds of metaseds of Preble Fm.	10		~90	
850	860	PK	BN	A/SA		<10mm	chips	Tertiary ash-flow tuffs			100	
860	870	PK	BN	A/SA		<6mm	chips	Tertiary ash-flow tuffs, adds of metaseds of Preble Fm.	5		~95	
870	880	PK	BN	VA/SA		<14mm	chips	Tertiary ash-flow tuffs			100	
880	890	PK	BN	VA/SA		<10mm	chips	Tertiary ash-flow tuffs			100	
890	900	PK	BN	VA/SA		<9mm	chips	Tertiary ash-flow tuffs, adds of metaseds of Preble Fm.	5		~95	
900	910	PK	BN	A/SA		<5mm	chips	Tertiary ash-flow tuffs			100	
910	920	PK	BG	A/SA		<6mm	chips	Tertiary ash-flow tuffs			100	
920	930	PK	BG	VA/SA		<16mm	chips	Tertiary ash-flow tuffs, adds of metaseds of Preble Fm.	5		~95	
930	940	PK	BG	A	SR	<12mm	MG	Tertiary ash-flow tuffs, adds of metaseds of Preble Fm., qtz	35		~50	15
940	950	PK	BN	A	SR	<8mm	MG	Tertiary ash-flow tuffs and metaseds of Preble Fm.	~50		~50	
950	960	PK	GY	VA	SR	<6mm	FG	Tertiary ash-flow tuffs and metaseds of Preble Fm.	~40		~60	
960	970	PK	GY	A	SR	<9mm	MG	Tertiary ash-flow tuffs and metaseds of Preble Fm.	~40		~60	
970	980	PK	GY	VA	SR	<8mm	FG	Tertiary ash-flow tuffs and metaseds of Preble Fm.	~50		~50	
980	990	PK	GY	A	SR	<8mm	fG	metaseds of Preble Fm. and Tertiary ash-flow tuffs	~70		30	
990	1000	PK	GY	A	SR	<8mm	FG	metaseds of Preble Fm., adds of Tertiary ash-flow tuffs	~85		15	

Abbrev	**Color**	**Abbrev**	**Round**		**Abbreviation - rock/mineral type**
BG	Beige	VA	very	angular	metaseds = metasediments
BL	Blue	A	angular		qtz = quartz
BN	Brown	SA	sub-	angular	qtz-fds-bio = quartz-feldspar-biotite
CH	Charcoa	SR	sub-	rounded	qtzites = quartzites
GN	Green	R	rounded		fel = felsic
GY	Gray				volcs = volcanics
OL	Olive				sst = sandstones
PK	Pink				ox = Fe oxidized
PE	Purple				adds = additions
RD	Red				
RY	Rusty	DK	Dark		
YL	Yellow	LT	Light		

Drill hole:

PVTG-2

FAIRBANK ENGINEERING LTD

Mud Log

PROJECT: Pumpernickel Valley — COORDINATES: 458256 E, 4513110 N. — NAD 83 — DATE: 25-30.08.05

HOLE NO.: PVTG-2 — ELEV 1519 m — AZIMUTH — DIP 90° — LOGGED BY: Adam Szybinski

LOCATION: Pumpernickel Valley — SECTION 5 — T 33N — R 40E — CONTRACTOR: WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Phyllite	Mudstone	Sulphides	Qtz
From	To	1	2	Angular	Rounded	Range	Class		%	%	%	%
0	10	BG	GY	SA	SR	<30mm	CG	metaseds of Preble Fm.: mudstones,quartzite, qtz schist, phyllite; qtz	~30	~50		~2
10	20	GY	OL/BG	A/SA		<10mm	chips	bedrock or boulders of phyllites, Preble Fm.		~100		
20	30	GY	DK	VA/SA		<20mm	chips	bedrock or boulders of mudstones, Preble Fm.		~100		
30	40	GY	OL	VA/SA		<18mm	chips	bedrock or boulders of mudstones, Preble Fm.		~100		
40	50	GY	OL	VA/SA		<7mm	chips	bedrock or boulders of mudstones, Preble Fm.		~100		
50	60	GY	BL	VA/SA		<7mm	chips	**bedrock**;weakly limey to mainly siliceous mudstones, Preble Fm.		~100		
60	70	GY	LT/BL	VA/SA		<7mm	chips	siliceous to weakly limey, variably foliated mudstones, Preble Fm.		~100		
70	80	GY	BL	VA/SA		<5mm	chips	siliceous to weakly limey, variably foliated mudstones, Preble Fm.		~100		
80	90	GY	BL	VA/SA		<15mm	chips	siliceous and variably foliated mudstones, Preble Fm.		~100		
90	100	GY	BL	VA/SA		<14mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
100	110	GY	CH/BL	VA/A		<10mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
110	120	GY	CH/BL	VA/SA		<14mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
120	130	GY	CH/BL	VA/SA		<25mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
130	140	GY	CH/BL	VA/SA		<16mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
140	150	GY	CH/BL	VA/SA		<16mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
150	160	GY/LT	BL/GN	VA/SA		<22mm	chips	mainly siliceous, variably foliated mudstones, Preble Fm.; qtz veinlets		~95		~5
160	170	GY/LT	BL/GN	VA/SA		<26mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, diss pyrite		~92	~2	~6
170	180	GY/DK	CH/BL	A/SA		<17mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, diss pyrite		~91	~3	~6
180	190	GY/DK	LT/BL	A/SA		<25mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, diss pyrite		~90	~3	~7
190	200	GY/DK	LT/BL	A/SA		<23mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
200	210	GY/DK	BL	VA/SA		<29mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
210	220	GY		VA/SA		<21mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, diss pyrite		~90	~4	~6
220	230	GY	DK	A		<31mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
230	240	GY	DK	A/SA		<22mm	chips	siliceous, foliated mudstones, Preble Fm., diss pyrite		~95		~5
240	250	GY	BL	VA/SA		<10mm	chips	fault breccia, siliceous to limey mudstones, Preble Fm., tr diss pyrite			tr	
250	260	GY	BL	VA/SA		<18mm	chips	fault breccia, siliceous to limey mudstones, Preble Fm., tr diss pyrite			tr	
260	270	GY	BL	VA/SA		<17mm	chips	fault breccia, siliceous to limey mudstones, Preble Fm., tr diss pyrite			tr	
270	280	GY	BL	VA/SA		<15mm	chips	fault breccia, siliceous to limey mudstones, Preble Fm., tr diss pyrite			tr	
280	290	GY	BL	VA/SA		<12mm	chips	fault breccia, siliceous to limey mudstones, Preble Fm., tr diss pyrite			tr	
290	300	GY	BL	VA/SA		<25mm	chips	fault breccia, siliceous to limey mudstones, Preble Fm., tr diss pyrite			tr	
300	310							no sample				
310	320	GY	BL	VA/SA		<24mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
320	330	CH/GY	BL	VA/SA		<14mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
330	340	CH/GY	BL	VA/SA		<16mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
340	350	CH/GY	BL	VA/SA		<14mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~92		~8
350	360	CH/GY	BL	VA/SA		<12mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~90		~10
360	370	CH/GY	BL	VA/SA		<13mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
370	380	CH/GY	BL	VA/SA		<18mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~95		~5

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	458256 E, 4513110 N.	NAD 83	DATE: 25-30.08.05
HOLE NO.	PVTG-2	ELEV 1519 m	AZIMUTH	DIP 90°	LOGGED BY: Adam Szybinski
LOCATION	Pumpernickel Valley	SECTION 5	T 33N	R 40E	CONTRACTOR: WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Phyllite	Mudstone	Sulphides	Qtz
From	To	1	2	Angular	Rounded	Range	Class		%	%	%	%
380	390	GY/CH	BL	VA/SA		<18mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~98	tr	<2
390	400	GY/CH	BL	VA/SA		<13mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~98	tr	<2
400	410	GY/CH	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~98	tr	<2
410	420	GY/CH	BL	VA/SA		<12mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~98	tr	<2
420	430	GY/CH	BL	VA/SA		<12mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~99	tr	~1
430	440	GY/CH	BL	VA/SA		<9mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~99	tr	~1
440	450	GY/CH	BL	VA/SA		<11mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~99	tr	~1
450	460	GY/CH	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~99	tr	~1
460	470	GY/CH	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~99	tr	~1
470	480	GY/CH	BL	VA/SA		<15mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, diss pyrite		~99	tr	~1
480	490	GY/CH	BL	VA/SA		<8mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~99	tr	~1
490	500	GY/CH	BL	VA/SA		<17mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~99	tr	~1
500	510	GY/CH	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~95		~5
510	520	GY/CH	BL	VA/SA		<12mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~95		~5
520	530	GY/CH	BL	VA/SA		<12mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~95		~5
530	540	GY/CH	BL	VA/SA		<9mm	chips	siliceous, foliated mudstones, Preble Fm.		~100		
540	550	GY/CH	BL	VA/SA		<9mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~98		~2
550	560	GY/CH	BL	VA/SA		<16mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~95		~5
560	570	GY/CH	BL	VA/SA		<15mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~95		~5
570	580	GY/CH	BL	VA/SA		<15mm	chips	mainly siliceous, somewhat phyllitic mudstones of the Preble Fm., qtz veinlet		~95	tr	~5
580	590	GY/CH	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~98		~2
590	600	GY/CH	BL	VA/SA		<10mm	chips	mainly siliceous, somewhat phyllitic mudstones of the Preble Fm.		~100		
600	610	GY	DK	VA/SA		<20mm	chips	mainly siliceous, somewhat phyllitic mudstones of the Preble Fm.		~100		
610	620	GY/CH	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~99		~1
620	630	GY/CH	BL	VA/SA		<9mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr diss pyrite		~99	tr	~1
630	640	GY/CH	BL	VA/SA		<8mm	chips	siliceous, foliated mudstones, Preble Fm., tr diss pyrite		~100	tr	
640	650	GY/CH	BL	VA/SA		<19mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	<2
650	660	GY/CH	BL	VA/SA		<11mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	<2
660	670	GY/CH	BL	VA/SA		<10mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	<2
670	680	GY		VA/SA		<11mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	~2
680	690	GY		VA/SA		<11mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	~2
690	700	GY/CH	DK	VA/SA		<5mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	~2
700	710	GY	LT	VA/SA		<8mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins		~90		~10
710	720	GY	CH	VA/SA		<7mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins		~88		~12
720	730	GY	CH	VA/SA		<12mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~85	tr	~15
730	740	GY	LT	VA/SA		<7mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins		~80		~20
740	750	GY	CH	VA/SA		<20mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~85	tr	~15
750	760	LT/CH	BL	VA/SA		<12mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins		~95		~5

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	458256 E, 4513110 N.	NAD 83	DATE: 25-30.08.05
HOLE NO.	PVTG-2	ELEV 1519 m	AZIMUTH	DIP 90°	LOGGED BY: Adam Szybinski
LOCATION	Pumpernickel Valley	SECTION 5	T 33N	R 40E	CONTRACTOR: WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Phyllite	Mudstone	Sulphides	Qtz
From	To	1	2	Angular	Rounded	Range	Class		%	%	%	%
760	770	CH	BL	VA/SA		<7mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins		~98		~2
770	780	CH	BL	VA/SA		<23mm	chips	bx, siliceous to weakly limey mudstones, Preble Fm., qtz veins		~95		~5
780	790	LT/CH	BL	VA/SA		<17mm	chips	bx, siliceous to weakly limey mudstones, Preble Fm., qtz veins		~95		~5
790	800	LT/CH	BL	VA/SA		<18mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~90	tr	~10
800	810	DK/GY	BL	VA/SA		<12mm	chips	siliceous to weakly limey mudstones, Preble Fm., qtz veins, tr pyrite		~95	tr	~5
810	820	GY	BL	VA/SA		<7mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~95	tr	~5
820	830	GY	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~95	tr	~5
830	840	GY	BL	VA/SA		<9mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~92	tr	~8
840	850	GY	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	~2
850	860	GY	BL	VA/SA		<7mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	~5
860	870	GY	BL	VA/SA		<9mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~96	tr	~4
870	880	GY	BL	VA/SA		<8mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~96	tr	~4
880	890	GY	BL	VA/SA		<7mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	~2
890	900	GY	BL	VA/SA		<6mm	chips	siliceous, foliated mudstones, Preble Fm., tr qtz		~100		tr
900	910	GY	BL	VA/SA		<8mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~99	tr	~1
910	920	GY	BL	VA/SA		<12mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~99	tr	~1
920	930	GY	BL	VA/SA		<9mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins		~98		~2
930	940	GY	BL	VA/SA		<10mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	~2
940	950	GY	BL	VA/SA		<16mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~98	tr	~2
950	960	GY	BL	VA/SA		<8mm	chips	siliceous, foliated mudstones, Preble Fm., tr qtz		~100		tr
960	970	GY	BL	VA/SA		<8mm	chips	siliceous, foliated mudstones, Preble Fm., tr qtz, tr pyrite		~100	tr	tr
970	980	GY	BL	VA/SA		<7mm	chips	siliceous, foliated mudstones, Preble Fm., tr qtz, tr pyrite		~100	tr	tr
980	990	GY	BL	VA/SA		<11mm	chips	siliceous, foliated mudstones, Preble Fm., tr qtz		~100		tr
990	1000	GY	BL	VA/SA		<13mm	chips	siliceous, foliated mudstones, Preble Fm., qtz veins, tr pyrite		~90	tr	~10

Abbrev	Color	Abbrev	Round		Abbreviation - rock/mineral type
BG	Beige	VA	very	angular	metaseds = metasediments
BL	Blue	A	angular		qtz = quartz
BN	Brown	SA	sub-	angular	qtz-fds-bio = quartz-feldspar-biotite
CH	Charcoa	SR	sub-	rounded	qtzites = quartzites
GN	Green	R	rounded		fel = felsic
GY	Gray				volcs = volcanics
OL	Olive				sst = sandstones
PK	Pink				ox = Fe oxidized
PE	Purple				adds = additions
RD	Red				
RY	Rusty	DK	Dark		
YL	Yellow	LT	Light		

Drill hole:

PVTG-3

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Mud Log

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PROJECT	Pumpernickel Valley	COORDINATES	459323 E,	4511695 N.	NAD 83	DATE:	30.8-17.9, 2005
HOLE NO.	PVTG-3	ELEV 4648'	AZIMUTH		DIP 90°	LOGGED BY:	Adam Szybinski
LOCATION	Pumpernickel Valley, Humboldt Co	SECTION 9	T 34N	R 40E		CONTRACTOR:	WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intrusives %	Volcanics %	Qtz %
From	To	1	2	Angular	Rounded	Range	Class					
0	10	BG	GY			<1.5mm	F	soil, small % of fine and medium sand				
10	20	BG	GY	SA	SR	<4mm	FG	soil, small % of fine and medium sand, few granules				
20	30	BG	GY	SA	SR	<15mm	MG	soil with clay, silt, and sand, pebbles of metaseds and intrusives				
30	40	BG	GY			<1.5mm	F	soil, small % of fine and medium sand				
40	50	BG	GY			<1.5mm	F	soil, small % of fine and medium sand				
50	60	BG	GY	SA	SR	<8mm	FG	soil with clay, silt, and sand; pebbles of metaseds, intrusives, quartz				
60	70	BG	GY	SA	SR	<8mm	FG	soil with clay, silt, and sand; pebbles of metaseds, intrusives, quartz				
70	80	BG	GY	SA	SR	<8mm	FG	soil with clay, silt, and sand; pebbles of metaseds, intrusives, quartz				
80	90	BG	DK	SA	SR	<8mm	FG	soil with clay, silt, and sand; pebbles of metaseds, intrusives, quartz				
90	100	BG	GY	SA	R	<6mm	FG	soil with clay, silt, and sand; pebbles of metaseds, intrusives, quartz				
100	110	BG		SA	R	<10mm	MG	clay, silt, and sand; pebbles of felsic intrusives, metaseds, and quartz	~40	~50		10
110	120	BG	GY	SA	SR	<25mm	CG	clay, silt, and sand; pebbles of metaseds, felsic intrusives, and quartz	~50	~45		5
120	130	BG	LT				F	clay and silt supported fine sand				
130	140	BN	LT				F	clay and silt supported fine sand				
140	150	BG	LT				F	clay and silt supported fine sand				
150	160	BG					F	clay and silt supported sand				
160	170	BG					F	clay and silt supported fine sand				
170	180	BG					F	clay and silt supported fine sand				
180	190	BG	DK				F	clay and silt supported fine sand				
190	200							no sample				
200	210	GY	BG	SA	SR	<12mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~55	~40		5
210	220	BG	GY	SA	SR	<8mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~35	~65		10
220	230	BG	GY	SA	SR	<8mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~42	~50		8
230	240	BG	DK	SA	SR	<7mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~35	~60		5
240	250	BG	GY	SA	SR	<7mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~20	~65		15
250	260	GY	BG	SA	SR	<9mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~55	~40		5
260	270	GY	BN	SA	SR	<9mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~30	~60		10
270	280	GY	BN	SA	SR	<9mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~65	~25		10
280	290	GY	BN	SA	SR	<10mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~57	~35		8
290	300	BG	DK	SA	SR	<10mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~55	~35		10
300	310	BN	LT	SA	SR	<8mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~70	~25		5
310	320	GY	BG	SA	R	<8mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~28	~60		12
320	330	BG	DK	SA	SR	<7mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~20	~70		10
330	340	GY	BG	SA	SR	<9mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~50	~40		10
340	350	GY	BN	SA	R	<12mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~62	~30		8
350	360	GY	BN	SA	SR	<11mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~35	~60		5
360	370	GY	BN	SA	SR	<9mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~32	~60		8
370	380	GY	BG	SA	SR	<10mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~45	~45		10

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459323 E,	4511695 N.	NAD 83	DATE:	30.8-17.9, 2005
HOLE NO.	PVTG-3	ELEV 4648'	AZIMUTH		DIP 90^o	LOGGED BY:	Adam Szybinski
LOCATION	Pumpernickel Valley	SECTION 9	T 34N	R 40E		CONTRACTOR:	WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intrusives %	Volcanics %	Qtz %
From	To	1	2	Angular	Rounded	Range	Class					
380	390	GY	BG	SA	SR	<8mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~60	~25		15
390	400	GY	BG	SA	SR	<5mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~55	~30		15
400	410	GY	BG	SA	SR	<6mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~50	~40		10
410	420	GY	BN	SA	SR	<14mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~52	~40		8
420	430	GY	BN	SA	R	<8mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~30	~60		10
430	440	GY	BN	SA	R	<9mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~60	~25		15
440	450	BN						bad sample				
450	460	GY	BN	A	SR	<12mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~60	~25		15
460	470	BN	PK	SA	SR	<13mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~45	~50		5
470	480	BN	PK	SA	SR	<11mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~55	~30		15
480	490	BN	PK	SA	R	<9mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~65	~30		5
490	500	GY	BN	SA	SR	<11mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~82	15		3
500	510	GY	BN	SA	SR	<9mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~75	15		10
510	520	GY	BN	SA	SR	<7mm	FG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~77	15		8
520	530	GY	BN		SR	<13mm	MG	metaseds, Preble Fm.(?), qtz-fds-bio granite, and quartz	~85	10		<5
530	540	GY		SA	SR	<10mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~85	<10		<5
540	550	GY		SA		<15mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~90	5		5
550	560	GY	PK	SA	SR	<10mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~77	18		5
560	570	GY	PK	SA	SR	<12mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~80	15		5
570	580	GY	PK	SA	SR	<15mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~84	8		8
580	590	GY		SA	SR	<13mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~87	5		8
590	600							no sample				
600	610	GY	PK	SA	SR	<11mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~84	8		8
610	620	GY	PK	SA	SR	<15mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~90	5		5
620	630	GY	PK	SA	SR	<16mm	MG	grey qtzite; lesser qtz-fds-bio granite, Tertiary volcanics, and quartz	~87	5	3	<5
630	640	GY	BG	SA	SR	<16mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~90	5		<5
640	650	GY	BG	SA	SR	<18mm	CG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~87	5		8
650	660	GY		SA	SR	<16mm	MG	grey quartzite (Preble Fm.?)	~100			
660	670	GY	BG	SA	SR	<15mm	MG	grey quartzite (Preble Fm.?), lesser qtz-fds-bio granite	>95	5		
670	680	GY		SA	SR	<14mm	MG	grey quartzite (Preble Fm.?)	~100			
680	690	GY	PK	SA	SR	<14mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~87	8		5
690	700	GY	PK	SA	SR	<13mm	MG	grey quartzite (Preble Fm.?), lesser qtz-fds-bio granite	~92	8		
700	710	GY	BN	SA	SR	<14mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~87	5		8
710	720	GY	BN	SA	SR	<11mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~94	3		3
720	730	GY	BN	SA	SR	<13mm	MG	grey quartzite, Preble Fm.(?); lesser quartz	~95			5
730	740	GY	BG	SA	SR	<17mm	CG	grey quartzite (Preble Fm.?), minor qtz-fds-bio granite	~97	<3		
740	750	GY	BG	SA	SR	<12mm	MG	grey quartzite, minor qtz-fds-bio granite and quartz	~98	<3		<3
750	760	GY	BG	SA	SR	<7mm	FG	grey quartzite, Preble Fm.(?); lesser quartz	~95			5

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459323 E, 4511695 N.	NAD 83	DATE: 30.8-17.9, 2005
HOLE NO.	PVTG-3	ELEV 4648'	AZIMUTH	DIP 90°	LOGGED BY: Adam Szybinski
LOCATION	Pumpernickel Valley	SECTION 9	T 34N	R 40E	CONTRACTOR: WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intrusive %	Volcanics %	Qtz %
From	To	1	2	Angular	Rounded	Range	Class					
760	770	GY	PK	SA	SR	<15mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~92	3		5
770	780	GY	PK	SA	SR	<9mm	MG	grey qtzite; lesser felsic intrusives and volcanics, and quartz	~87	3	2	8
780	790	GY	PK	SA	SR	<8mm	FG	grey quartzite; lesser qtz-fds-bio granite and quartz	~93	2		5
790	800	GY	PK	SA	SR	<6mm	FG	grey qtzite; lesser quartz	~97			<3
800	810	GY	BN	SA	SR	<10mm	MG	grey quartzite; lesser qtz-fds-bio granite and quartz	~88	2		10
810	820	GY	PK/BG	SA	SR	<7mm	FG	grey quartzite; lesser qtz-fds-bio granite and quartz	~93	2		5
820	830	GY	PK/BG	SA	SR	<9mm	MG	grey qtzite; lesser quartz	~90			10
830	840	GY	PK/BG	SA	SR	<9mm	MG	grey qtzite; minor felsic intrusives and volcanics, and quartz	~92	3	2	3
840	850	GY	BG	SA	SR	<12mm	MG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~89	~1		10
850	860	GY	PK	SA	SR	<8mm	FG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~93	2		5
860	870	GY	PK	SA	SR	<7mm	FG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~87	5		8
870	880	GY	DK/BG	SA	SR	<7mm	FG	grey quartzite, Preble Fm.(?); lesser qtz-fds-bio granite and quartz	~90	5		5
880	890	GY	DK/BG	SA	SR	<8mm	FG	grey qtzite; minor felsic intrusives and volcanics, and quartz	~92	2	1	5
890	900	GY	DK/BG	SA	R	<9mm	MG	grey qtzite; minor felsic intrusives and volcanics, and quartz	~91	3	1	5
900	910	GY	LT/BG	SA	SR	<5mm	FG	grey qtzite;minor quartz	~98			2
910	920	GY	DK	SA	SR	<17mm	CG	grey qtzite;minor quartz	~98			2
920	930	GY	BG	SA	SR	<17mm	CG	grey qtzite;minor quartz	~95			5
930	940	GY	DK	SA	SR	<16mm	MG	grey qtzite;minor quartz	~97			3
940	950	GY	PK	SA	SR	<14mm	MG	grey qtzite, Preble Fm., adds minor fel intrusives and qtz	~94	1		5
950	960	GY	PK	SA	SR	<10mm	MG	grey qtzite;minor quartz	~97			3
960	970	GY	PK	SA	SR	<11mm	MG	grey qtzite, Preble Fm., adds minor fel intrusives and qtz	~93	2		5
970	980	GY	BG	SA	SR	<15mm	MG	grey qtzite, Preble Fm., adds minor fel intrusives and qtz	~87	8		5
980	990	GY	BG	SA	SR	<9mm	MG	grey qtzite; lesser felsic intrusives and volcanics, and quartz	~82	5	5	8
990	1000	GY	BG	SA	SR	<7mm	FG	grey qtzite; lesser felsic intrusives and volcanics, and quartz	~80	10	5	5
1000	1010	GY	BG/PK	SA/A	SR	<18mm	CG	qtzites, qtz schists, cherts; lesser felsic volcanics and intrusives, qtz	~68	17	10	5
1010	1020	GY	BG/PK	SA	SR	<13mm	MG	qtzites, qtz schists, cherts; lesser felsic volcanics and intrusives, qtz	~77	5	10	8
1020	1030	GY	BG/PK	SA	SR/R	<7mm	FG	qtzites, qtz schists, cherts; lesser felsic volcanics and intrusives, qtz	~87	<5	<3	5
1030	1040	GY	BG/PK	SA	SR	<15mm	MG	qtzites, qtz schists, cherts; lesser felsic volcanics and intrusives, qtz	~77	10	8	5
1040	1050	GY	BG/PK	A/SA	SR	<7mm	FG	qtzites, qtz schists, cherts; lesser intrusives and qtz	~85	10		5
1050	1060	GY	BG/PK	A/SA	SR	<9mm	MG	qtzites, qtz schists, cherts; lesser felsic volcanics and intrusives, qtz	~81	8	3	8
1060	1070	GY	BG/PK	SA	SR	<15mm	MG	qtzites, qtz schists, cherts; lesser felsic volcanics and intrusives, qtz	~87	5	3	5
1070	1080	GY	BG/PK	SA	SR	<5mm	FG	qtzites, qtz schists, cherts; lesser felsic volcanics and intrusives, qtz	~77	10	3	10
1080	1090	GY	BG/PK	SA	SR	<6mm	FG	qtzites, qtz schists; some felsic intrusives and qtz	~72	8		20
1090	1100	GY	BG/PK	SA	SR	<7mm	FG	qtzites, qtz schists; lesser felsic intrusives and qtz	~78	12		10
1100	1110	GY	PK	SA	SR	<10mm	MG	qtzites, qtz schists; lesser felsic intrusives and qtz	~87	5		8
1110	1120	GY	BG	SA	SR	<7mm	FG	qtzites, qtz schists; lesser felsic intrusives and qtz	~75	15		10
1120	1130	GY	BG	SA	SR	<8mm	FG	qtzites, qtz schists; lesser felsic intrusives and qtz	~90	5		5
1130	1140	GY	BG	SA	SR	<8mm	FG	qtzites, qtz schists; lesser felsic volcanics and intrusives, qtz	~89	5	1	5

FAIRBANK ENGINEERING LTD

Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459323 E,	4511695 N.	NAD 83	DATE:	30.8-17.9, 2005
HOLE NO.	PVTG-3	ELEV 4648'	AZIMUTH	DIP 90°		LOGGED BY:	Adam Szybinski
LOCATION	Pumpernickel Valley	SECTION 9	T 34N	R 40E		CONTRACTOR:	WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intrusive %	Volcanics %	Qtz %
From	To	1	2	Angular	Rounded	Range	Class					
1140	1150	GY	BG	SA	SR	<7mm	FG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~83	8	1	8
1150	1160	GY	BG	SA	SR	<8mm	FG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~84	5	3	8
1160	1170	GY	BG	SA	SR	<6mm	FG	qtzites, qtz schists; lesser fel intrusives, qtz	~90	5		5
1170	1180	GY	PK/BG	SA	SR	<6mm	FG	qtzites, qtz schists; lesser fel intrusives, qtz	~89	<3		8
1180	1190	BG	GY	SA	SR	<5mm	FG	qtzites, qtz schists; lesser fel intrusives, qtz	~90	5		5
1190	1200	GY	BG	SA	SR	<6mm	FG	qtzites, qtz schists; lesser fel intrusives, qtz	~80	12		8
1200	1210	GY	BN	SA	SR	<7mm	FG	qtzites, qtz schists; lesser fel intrusives, qtz	~82	8		10
1210	1220	GY	BN	SA	SR	<6mm	FG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~92	5	7	8
1220	1230	GY	BN	SA	SR	<7mm	FG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~84	3	3	10
1230	1240	GY	BN	SA	SR	<13mm	MG	qtzites, qtz schists; lesser fel intrusives, qtz	~83	5		12
1240	1250	GY	BN	SA	SR	<7mm	FG	qtzites, qtz schists; lesser fel intrusives, qtz	~83	<5		12
1250	1260	GY	BN	SA	SR/R	<9mm	MG	qtzites, qtz schists; lesser fel intrusives, qtz	~90			10
1260	1270	GY	PK/BG	SA	SR	<8mm	FG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~86	<3	1	10
1270	1280	GY	BN	SA	SR	<6mm	FG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~91	1	10	8
1280	1290	GY	BG	SA	SR	<8mm	FG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~84	3	3	10
1290	1300	BN	GY	SA	SR	<8mm	CG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~86	3	3	8
1300	1310	GY	PK	SA	SR	<10mm	MG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~85	2	5	8
1310	1320	GY	BG	SA	SR	<10mm	MG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~85	5	5	5
1320	1330	GY	PK/BG	SA	SR	<10mm	MG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~94	8	3	<3
1330	1340	BG		SA	SR	<10mm	MG	qtzites, qtz schists; lesser fel volcanics and qtz	~97		12	3
1340	1350	GY	BG	SA	SR	<7mm	FG	qtzites, qtz schists; lesser fel volcanics and qtz	~93		8	5
1350	1360	GY	PK/BG	SA	SR	<9mm	MG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~84	3	5	8
1360	1370	GY	BG	SA	SR	<9mm	MG	qtzites, qtz schists; lesser fel intrusives, qtz	~89	3		8
1370	1380	GY	BN	SA	SR	<11mm	MG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~85	3	2	10
1380	1390	GY	BN	SA	SR	<9mm	MG	qtzites, qtz schists; lesser fel intrusives, qtz	~94	3		<3
1390	1400	GY	BN	SA	SR	<9mm	MG	qtzites, qtz schists; lesser fel volcanics and intrusives, qtz	~89	5	3	3
1400	1410	GY	BN/PK	SA	SR	<10mm	MG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~90	5	2	<3
1410	1420	GY	LT	SA	SR	<12mm	MG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~89	3	3	5
1420	1430	BG	GY	SA	SR	<8mm	FG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~85	5	3	10
1430	1440	GY	PK	A/SA	SR	<8mm	FG	~10% of bright green chips of siltstone (?); otherwise like above	~87	3	10	
1440	1450	GY	PK	A/SA	SR	<6mm	FG	~15% of multicoloured chips of siltstone (?); otherwise like above	~87		5	8
1450	1460	GY	BG	A/SA	SR	<10mm	MG	~15% of multicoloured chips of siltstone (?); otherwise like above	~92	3		5
1460	1470	GY	BG	SA	SR	<11mm	MG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~84	3	8	5
1470	1480	GY	BG/PK	SA	SR	<8mm	FG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~73	5	12	10
1480	1490	GY	BG	SA	SR	<7mm	FG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~78	5	5	12
1490	1500	BN	GY	SA	SR	<8mm	FG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~75	3	10	<5
1500	1510	GY	PK/BN	SA	SR	<8mm	FG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~70	15	5	10
1510	1520	GY	PK/BN	A/SA	SR	<6mm	FG	qtzites, qtz schists, phyllites; minor fel volcanics and intrusives, qtz	~72	<5	8	5

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459323 E, 4511695 N.	NAD 83	DATE: 30.8-17.9, 2005
HOLE NO.	PVTG-3	ELEV 4648'	AZIMUTH	DIP 90°	LOGGED BY: Adam Szybinski
LOCATION	Pumpernickel Valley	SECTION 9	T 34N	R 40E	CONTRACTOR: WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intrusive %	Volcanics %	Qtz %
From	To	1	2	Angular	Rounded	Range	Class					
1520	1530	GY	RD/BN	A/SA	SR	<6mm	FG	~5% of bright green to pinkish siltstone (?); otherwise like above	~83	5	3	<3
1530	1540	GY	RD/BN	A/SA	SR	<6mm	FG	~15% of bright green to pinkish red siltstone (?); otherwise like above	~95		5	
1540	1550	GY	RD/BN	A/SA	SR	<6mm	FG	~15% of bright green to pinkish red siltstone (?); otherwise like above	~84	10	3	3
1550	1560	GY	PK/BN	A	SR	<8mm	FG	~20% of bright green to pinkish red siltstone (?); otherwise like above	~97		3	
1560	1570	GY	PK/BN	A	SR	<9mm	MG	~25% of bright green to pinkish red siltstone (?); otherwise like above	~87	5	3	5
1570	1580	GY	PK/BN	A	SR	<7mm	FG	~25% of bright green to pinkish red siltstone (?); otherwise like above	~87		8	5
1580	1590	GY	PK/BN	A	SR	<7mm	FG	~12% of bright green to pinkish red siltstone (?); otherwise like above	~87	3	5	5
1590	1600	GY	PK/BN	A	SR/R	<6mm	FG	~12% of bright green to pinkish red siltstone (?); otherwise like above	~87		8	5

Abbrev	**Color**	**Abbrev**	**Round**		**Abbreviation - rock/mineral type**
BG	Beige	VA	very	angular	metaseds = metasediments
BL	Blue	A	angular		qtz = quartz
BN	Brown	SA	sub-	angular	qtz-fds-bio = quartz-feldspar-biotite
CH	Charcoa	SR	sub-	rounded	qtzites = quartzites
GN	Green	R	rounded		fel = felsic
GY	Gray				volcs = volcanics
OL	Olive				sst = sandstones
PK	Pink				ox = Fe oxidized
PE	Purple				adds = additions
RD	Red				
RY	Rusty				
YL	Yellow				
DK	Dark				
LT	Light				

Drill hole:

PVTG-4

FAIRBANK ENGINEERING LTD

Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459937 E,	4514391 N.	NAD 83	DATE:	12.9-17.9, 2005
HOLE NO.	PVTG-4	ELEV	4727'	AZIMUTH	DIP 90°	LOGGED BY:	Adam Szybinski
LOCATION	Pumpernickel Vly, Humboldt Co.	SECTION	33	T 34N	R 40E	CONTRACTOR:	WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intr/Volcs %	Qtz %	Fe ox %
From	To	1	2	Angular	Rounded	Range	Class					
0	10	BG	GY	A/SA	SR	<35mm	VCG	metaseds, Preble Fm. and Havallah: qtzites, mudstones, qtz schists	~100			
10	20	GY	BG	A	SR	<20mm	CG	metaseds, Preble Fm. and Havallah: qtzites, mudstones, qtz schists	~100			
20	30	GY	BG	SA	SR	<20mm	CG	metaseds, Preble Fm. and Havallah, like above; some qtz and Fe ox	~90		10	~15
30	40	BG	GY	SA	SR	<38mm	VCG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~80	15	5	~15
40	50	BG		SA	SR	<40mm	VCG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~85	10	5	~5
50	60	BG	GY	SA	SR	<30mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~90	5	5	~10
60	70	BG	GY	A/SA	SR	<20mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives	~90	10		
70	80	BG		SA	SR	<25mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~88	5	7	~15
80	90	GY		SA	SR	<20mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~90	5	5	~10
90	100	BG	GY	SA	R	<30mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~100	<3	10	3
100	110	BG	GY	SA	R	<20mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~85	>5	10	5
110	120	BG	GY	SA	SR	<18mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~82	10	8	~10
120	130	GY		SA	SR	<28mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~85	5	10	~10
130	140	GY		SA	SR	<16mm	MG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~80	10	10	~15
140	150	BG	DK	SA	SR	<22mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~75	20	5	5
150	160	GY		SA	SR	<10mm	MG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~72	20	8	~5
160	170	BG	GY			<2mm	F	poor sample				
170	180	GY		SA	SR	<31mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~90	5	5	~15
180	190	GY	BN	SA	SR	<46mm	VCG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives	~80	10	10	
190	200	GY	LT	SA	SR	<21mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~75	10	15	8
200	210	GY	BG	SA	SR	<12mm	MG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~82	8	10	~5
210	220	GY	BN	SA	R	<17mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~82	10	8	~5
220	230	GY	BN	SA	R	<14mm	MG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~81	7	12	~5
230	240	GY	PK	SA	R	<15mm	MG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~92	8	10	~5
240	250	GY	PK	SA	R	<17mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~79	6	15	~5
250	260	GY	PK	SA	SR	<15mm	MG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~83	5	15	~5
260	270	GY	PK	SA	R	<13mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~85	5	10	~5
270	280	GY	BN	SA	R	<22mm	CG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~92	3	5	3
280	290	GY	BN	SA	SR	<17mm	MG	metaseds, Preble Fm. and Havallah, adds fel volcs and intrusives, qtz	~89	3	8	3
290	300	GY	BN	SA	R	<20mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~90	3	7	3
300	310	GY	BN	SA	R	<22mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~87	8	5	
310	320	BN	GY	SA	R	<19mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~82	10	8	
320	330	GY	BN	SA	SR	<15mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~88	5	7	
330	340	GY	PK	SA	SR	<16mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~90	4	6	
340	350	GY	BG	SA	SR	<18mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~87	3	10	
350	360	GY	BG	SA	SR	<21mm	FG	metaseds, Edna Fm. and Havallah: adds qtz	~93		7	
360	370	GY	BG	SA	R	<18mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~73	5	10	
370	380	GY	BG	SA	SR	<16mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~87	5	8	

FAIRBANK ENGINEERING LTD

Mud Log

PROJECT Pumpernickel Valley
HOLE NO. PVTG-4
LOCATION Pumpernickel Vly, Humboldt Co.

COORDINATES 459937 E, 4514391 N. NAD 83
ELEV 4727' AZIMUTH DIP 90°
SECTION 33 T 34N R 40E

DATE: 12.9-17.9, 2005
LOGGED BY: Adam Szybinski
CONTRACTOR: WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Meta-Seds %	Intr/Volcs %	Qtz %	Fe ox %
From	To	1	2	Angular	Rounded	Range	Class					
380	390	GY	BG	SA	SR	<23mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~87	3	10	
390	400	GY		SA	SR	<22mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~89	3	8	
400	410	GY	GN	SA	SR	<21mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~93	1	6	
410	420	GY	BG	SA	SR	<25mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~94	1	5	
420	430	GY	BG	SA	SR	<20mm	CG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	90	2	8	
430	440	GY		SA	SR	<28mm	CG	metaseds, Edna Fm. and Havallah: adds qtz	~95		5	
440	450	GY	BG	SA	SR	<17mm	CG	metaseds, Edna Fm. and Havallah	~100			
450	460	GY	BG	A	SR	<22mm	CG	metaseds, Edna Fm. and Havallah: adds qtz	~95		5	
460	470	GY	BG	SA		<16mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~90	2	8	
470	480	BG	OL	SA		<13mm	MG	metaseds, Edna Fm. and Havallah: adds qtz	~85		15	
480	490	GY	BG	SA	SR	<13mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~88	2	10	
490	500	GY	OL	SA	SR	<15mm	MG	metaseds, Edna Fm. and Havallah: adds qtz	~90		10	
500	510	GY	BG	SA	SR	<5mm	FG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~87	5	8	
510	520	GY	OL	SA	SR	<8mm	FG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~72	20	8	
520	530	GY	OL	SA	SR	<15mm	MG	metaseds, Edna Fm. and Havallah: adds qtz	~90		10	
530	540	GY	PK	SA	SR	<8mm	FG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~70	20	10	
540	550	GY	OL	SA	SR	<13mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~85	5	10	
550	560	GY	OL	SA	SR	<8mm	FG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~77	8	15	
560	570	GY		SA	SR	<11mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~80	10	10	
570	580	GY	OL	SA		<13mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~85	5	12	
580	590	GY	OL	SA		<11mm	MG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~87	5	8	
590	600	GY	OL	SA	SR	<7mm	FG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~87	3	10	
600	610	GY	OL	SA	SR	<6mm	FG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives	~95	5		
610	620	GY		SA		<6mm	FG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~80	2	18	
620	630	GY	OL	SA		<7mm	FG	metaseds, Edna Fm. and Havallah: adds fel volcs and intrusives, qtz	~84	1	15	
630	640	GY	BG	SA	SR	<10mm	MG	metaseds, Edna Fm. and Havallah	~100			
640	650	GY	BG	SA		<13mm	chips	chert blocks, Edna Fm. or Havallah sequence	~90		10	
650	660	GY	BG	A	SR	<20mm	chips	chert blocks, Edna Fm. or Havallah sequence	~87	3	10	15
Bedrock									Qtzite%	Chert%	Qtz %	Fe ox%
660	670	BG	RY	A/SA		<10mm	chips	cherts, ox qtzites, qtz sst, Edna Fm. or Havallah	~60	~40		~60
670	680	BN		A/SA		<8mm	chips	cherts, ox qtzites, qtz sst, Edna Fm. or Havallah	~15	~50		~15
680	690	BN		A/SA		<10mm	chips	cherts, ox qtzites, qtz sst, Edna Fm. or Havallah	~30	~60		~30
690	700	BN	GY	A/SA		<12mm	chips	cherts, ox qtzites, qtz sst, Edna Fm. or Havallah	~30	~60	5	~30
700	710	BN		A	SR	<14mm	chips	cherts, ox qtzites, qtz sst, Edna Fm. or Havallah	~42	50	8	~40
710	720	BN		A	SR	<10mm	chips	cherts, ox qtzites, qtz sst, Edna Fm. or Havallah	~51	45	4	~40
720	730	BG	RY	A/SA		<16mm	chips	ox qtzites, qtz sst and cherts, Edna Fm.	~87	8	5	~80
730	740	GY	RY	A/SA		<15mm	chips	ox qtzites, qtz sst and cherts, Edna Fm.	~92	5	3	~60
740	750	BG	RY	A/SA		<10mm	chips	ox qtzites, qtz sst and cherts, Edna Fm.	~92	5	3	~70

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459937 E, 4514391 N.	NAD 83	DATE: 12.9-17.9, 2005
HOLE NO.	PVTG-4	ELEV 4727'	AZIMUTH	DIP 90^o	LOGGED BY: Adam Szybinski
LOCATION	Pumpernickel Vly, Humboldt Co.	SECTION 33	T 34N	R 40E	CONTRACTOR: WDC

DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Qtzites	Chert	Qtz	Fe ox
From	To	1	2	Angular	Rounded	Range	Class		%	%	%	%
750	760	GY	BG	A/SA		<12mm	chips	ox qtzites and qtz ssts, Edna Fm.	~100			~50
760	770	GY	BG	A/SA		<14mm	chips	ox qtzites and qtz ssts, Edna Fm., adds qtz	~98		2	~50
770	780	BG	RY	A/SA		<10mm	chips	ox qtzites and qtz ssts, Edna Fm., adds qtz	~95		5	~60
780	790	RY		A/SA		<10mm	chips	ox qtzites and qtz ssts, Edna Fm., adds qtz	~97		3	~70
790	800	GY	RY	A/SA		<9mm	chips	ox qtzites and qtz ssts, Edna Fm., adds qtz	~97		3	~65
800	810	GY	RY	A/SA		<13mm	chips	ox qtzites and qtz ssts, Edna Fm., adds qtz	~95		5	~65
810	820	GY	OL	A/SA		<12mm	chips	ox qtzites and qtz ssts, Edna Fm., adds qtz	~95		5	~30
820	830	GY	OL	A/SA		<12mm	chips	ox qtzites and qtz ssts, Edna Fm., adds qtz	~95		5	~20
830	840	OL	RY	VA/SA		<10mm	chips	ox qtzites and qtz ssts, Edna Fm., adds qtz	~97		3	~10
840	850	GY	PE	VA/SA		<9mm	chips	argillite, jasper, adds chert and qtz (Edna Fm.?)			8	
850	860	GY	PE	VA/SA		<7mm	chips	argillite, jasper, adds chert and qtz (Edna Fm.?)			10	
860	870	PE	OL	VA/SA		<6mm	chips	argillite, siltst, some chert (Edna Fm.?), adds qtz		~10	~10	
870	880	GY	LT	VA/A		<6mm	chips	chert, opaline Si, siliceous siltsts (Edna Fm.?)		~75		
880	890	GY	OL	VA/A		<6mm	chips	chert, opaline Si, siliceous siltsts (Edna Fm.?)		~75		
890	900	GY	OL	VA/A		<6mm	chips	chert, opaline Si, siliceous siltsts (Edna Fm.?), adds qtz		~45	2	
900	910	GY	OL	VA/A		<7mm	chips	chert, opaline Si, siliceous siltsts (Edna Fm.?)		~80		
910	920	GY	OL	VA/A		<8mm	chips	chert, opaline Si, siliceous siltsts (Edna Fm.?)		~90		
920	930	GY	OL	VA/A		<8mm	chips	chert, opaline Si, siliceous siltsts (Edna Fm.?)		~85		
930	940	GY	CH	VA/A		<6mm	chips	chert, opaline Si, siliceous siltsts (Edna Fm.?)		~10		
940	950	GY	RY	VA/A		<6mm	chips	ox siltsts and fine qtzites, some cherts, Edna Fm.		5		~50
950	960	GY	RY	VA/A		<5mm	chips	ox siltsts and fine qtzites, some cherts, Edna Fm.		~15	2	~45
960	970	GY	RY	VA/A		<6mm	chips	ox siltsts and fine qtzites, some cherts, Edna Fm.		~12	5	~45
970	980	GY	OL	VA/A		<6mm	chips	chert, opaline Si, siliceous siltsts (Edna Fm.?)		~50		~10
980	990	GY	BN	VA/A		<5mm	chips	ox siltsts and qtzites, Edna Fm.		5	5	~30
990	1000	GY	BN	VA/A		<6mm	chips	ox ssts and qtzites, cherts, and mudst chips, Edna Fm.		~15	5	~10
1000	1010	GY	BG	VA/A		<7mm	chips	partly ox ssts and qtzites, adds cherts, mudstone chips; Edna Fm.		~15	10	~25
1010	1020	GY	BG	VA/A		<6mm	chips	partly ox ssts and qtzites, adds cherts, mudstone chips; Edna Fm.		5	5	~45
1020	1030	BN	RY	VA/A		<8mm	chips	mainly ox ssts and qtzites, adds cherts, mudstone chips; Edna Fm.		5	4	~70
1030	1040	GY	RY	VA/A		<6mm	chips	partly ox ssts and qtzites, adds cherts, mudstone chips; Edna Fm.		<5	3	~35
1040	1050	GY	BG	VA/A		<6mm	chips	mainly cherty mudstones, adds ox ssts and qtzites, cherts; Edna Fm.?		~5	<2	~15
1050	1060	GY	BG	VA/A		<7mm	chips	mainly cherty mudstones, adds ox ssts and qtzites; Edna Fm.			4	~5
1060	1070	GY	LT	VA/A		<8mm	chips	mainly cherts, adds opaline silica, siliceous siltstones (Edna Fm.?)		~60		<5
1070	1080	GY	LT	VA/A		<6mm	chips	mainly cherts, adds opaline silica, siliceous siltstones (Edna Fm.?)		~70		
1080	1090	GY		VA/SR		<10mm	chips	mainly cherts, adds opaline silica, siliceous siltstones (Edna Fm.?)		~35		
1090	1100	GY	LT	VA/A		<12mm	chips	mainly cherts, adds opaline silica, siliceous siltstones (Edna Fm.?)		~70		~10
1100	1110	GY	BN	VA/A		<8mm	chips	partly ox ssts and qtzites, adds cherts; Edna Fm.		5	5	~50
1110	1120	GY	BN	VA/A		<7mm	chips	partly ox ssts and qtzites, adds cherts, mudstone chips; Edna Fm.		<5	8	
1120	1130	GY	BG	VA/A		<5mm	chips	oxidized sandstones and quartzites mixed with cherts: Edna Fm.		~30		

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Mud Log

PROJECT	Pumpernickel Valley	COORDINATES	459937 E,	4514391 N.	NAD 83	DATE:	12.9-17.9, 2005
HOLE NO.	PVTG-4	ELEV	4727'	AZIMUTH	DIP 90°	LOGGED BY:	Adam Szybinski
LOCATION	Pumpernickel Vly, Humboldt Co.	SECTION	33	T 34N	R 40E	CONTRACTOR:	WDC

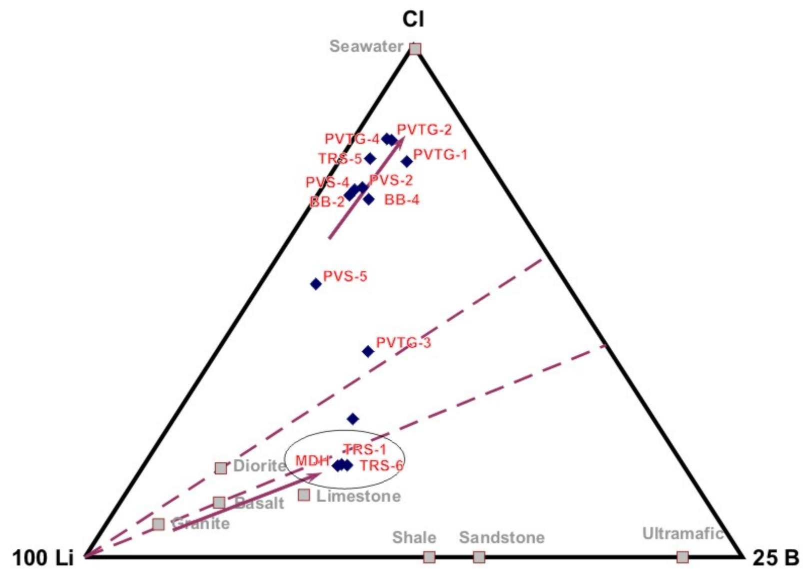
DEPTH (feet)		COLOUR		ROUNDNESS		GRAIN SIZE		LITHOLOGY DESCRIPTION / COMMENTS	Qtzites	Chert	Qtz	Fe ox
From	To	1	2	Angular	Rounded	Range	Class		%	%	%	%
1130	1140	GY	BG	A/SA		<6mm	chips	ox ssts and qtzites mixed with cherts: Edna Fm.	~80	10	10	
1140	1150	BG	GY	A/SA		<6mm	chips	ox ssts and qtzites mixed with cherts: Edna Fm.				
1150	1160	GY	BN	A/SA		<7mm	chips	ox ssts and qtzites mixed with cherts: Edna Fm.				
1160	1170	GY	BN	A/SA		<7mm	chips	ox ssts and qtzites mixed with cherts: Edna Fm.				
Abbrev	**Color**			**Abbrev**	**Round**			**Abbreviation - rock/mineral type**				
BG	Beige			VA	very	angular		metaseds = metasediments				
BL	Blue			A	angular			qtz = quartz				
BN	Brown			SA	sub-	angular		qtz-fds-bio = quartz-feldspar-biotite				
CH	Charcoa			SR	sub-	rounded		qtzites = quartzites				
GN	Green			R	rounded			fel = felsic				
GY	Gray							volcs = volcanics				
OL	Olive							sst = sandstones				
PK	Pink							ox = Fe oxidized				
PE	Purple							adds = additions				
RD	Red											
RY	Rusty											
YL	Yellow											
DK	Dark											
LT	Light											

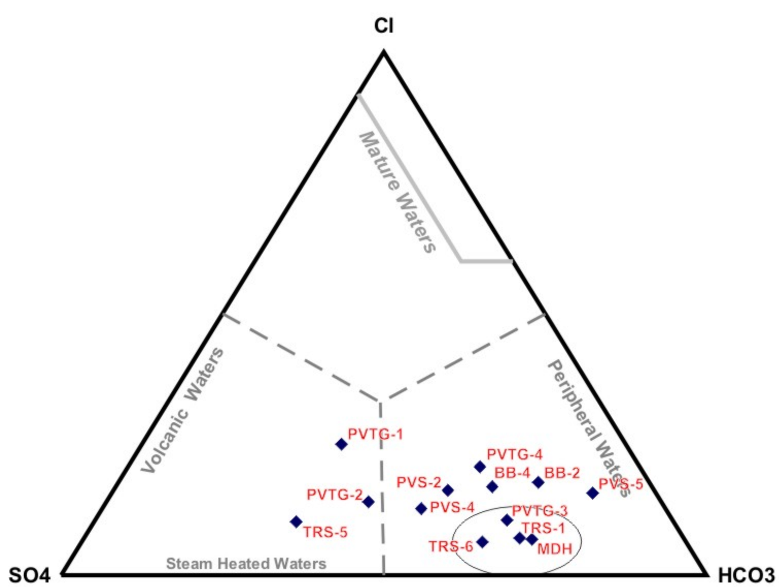
Appendix C

Geochemical data and diagrams
for water samples collected within
and near the project area;
analyzed by Thermochem Inc.

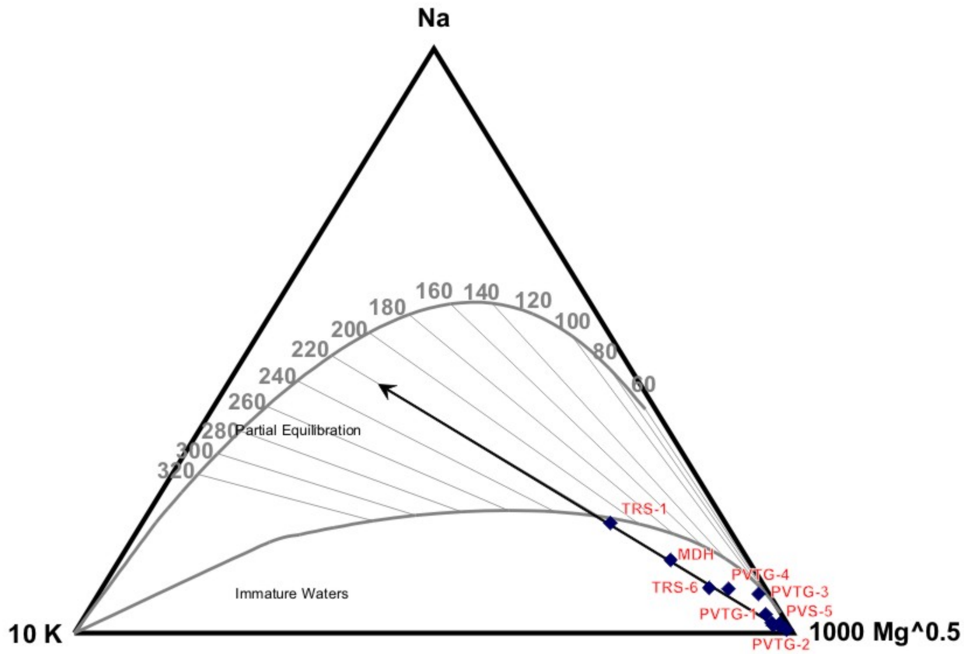
Sample Label	Temp °C	pH	Li	Na	K	Ca	Mg	SiO2	B	Cl	SO4	HCO3	NH4	sum cations	sum anions	Balance
BB2	20.3	8.07	-0.20	48.0	3.16	62.6	14.0	30.1	0.166	58.6	56.9	215	-0.255	6.47	6.36	2%
BB4	22.8	8.22	-0.20	63.8	3.64	70.4	14.5	32.1	0.302	64.2	93.6	221	-0.255	7.60	7.38	3%
MDH	94.5	7.84	1.09	204	17.5	20.3	1.57	154	2.53	37.9	130	381	-0.255	10.62	10.02	6%
PVS-2	16.1	7.98	-0.20	74.0	3.44	66.9	18.7	25.8	0.230	66.8	131	212	-0.255	8.21	8.09	2%
PVS-4	12.0	7.72	-0.20	46.7	5.04	115	19.2	17.9	-0.18	62.2	185	241	-0.255	9.51	9.56	-1%
PVS-5	22.5	8.01	-0.20	43.0	5.15	19.9	5.81	40.3	0.179	28.1	17.5	133	-0.255	3.50	3.34	5%
TRS-1	68.0	7.82	1.15	210	17.8	6.88	0.529	144	2.59	39.0	141	373	-0.255	10.14	10.15	0%
TRS-5	15.5	7.81	-0.20	72.8	6.37	213	46.7	30.8	0.205	88.5	507	270	-0.255	17.83	17.48	2.0%
TRS-6	49.0	7.59	1.11	202	20.3	33.9	4.84	88.4	2.70	39.1	195	383	-0.255	11.56	11.44	1.0%
PV TG-1	25.0	7.92	0.24	144	10	89	18.7	25.1	0.83	153	270	189	-0.511	12.54	13.05	-3.9%
PV TG-2	12.0	7.9	-0.10	60	9	103	18.7	27.0	0.19	65	211	189	-0.511	9.57	9.33	3%
PV TG-3	15.0	7.9	0.82	265	5	55	13.4	21.7	2.05	89	218	541	-0.511	15.62	15.91	-2%
PV TG-4	21.0	7.95	0.12	136	10	22	2.5	15.7	0.19	76	92	201	-0.511	7.51	7.37	1.9%

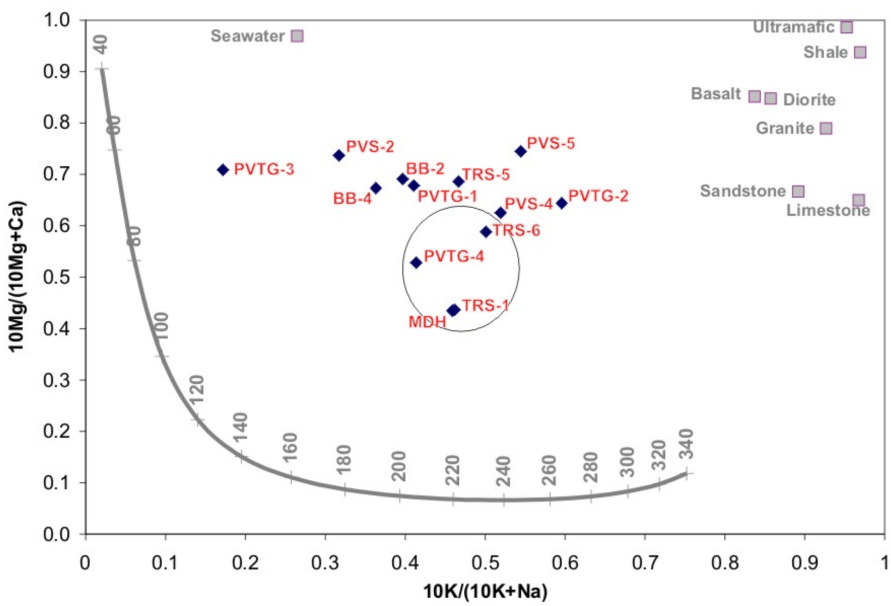
Diagrams: Tclb and Tchs



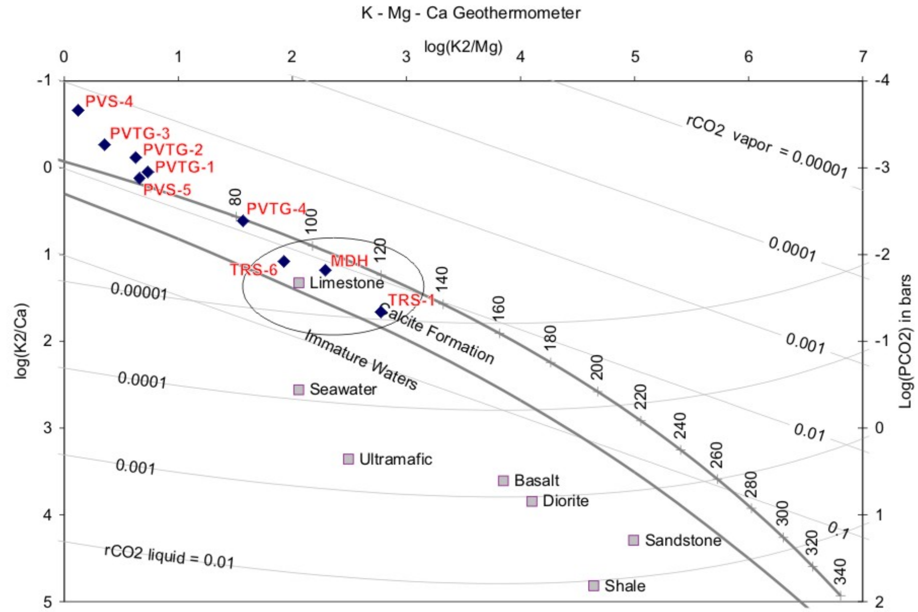


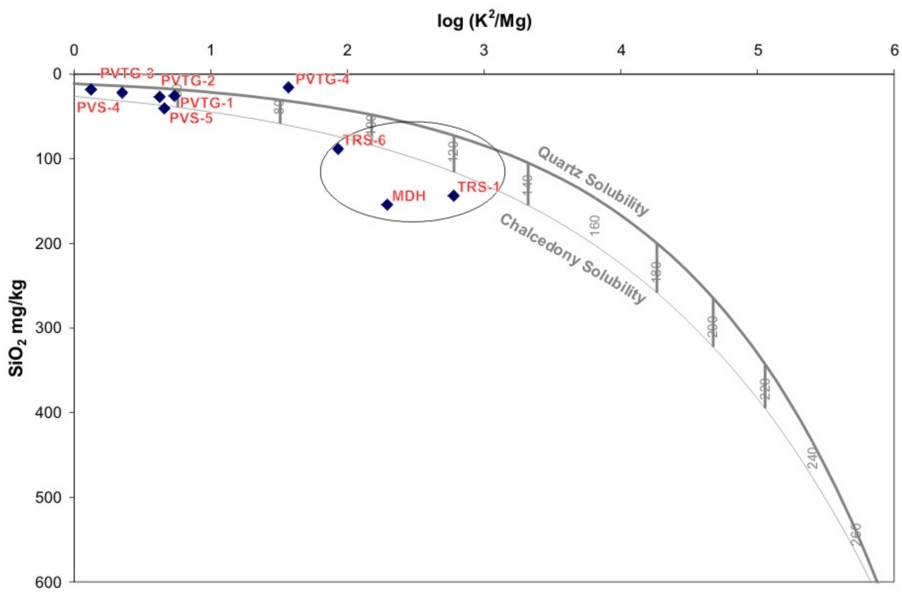
Diagrams: Tnkm and Xmckn



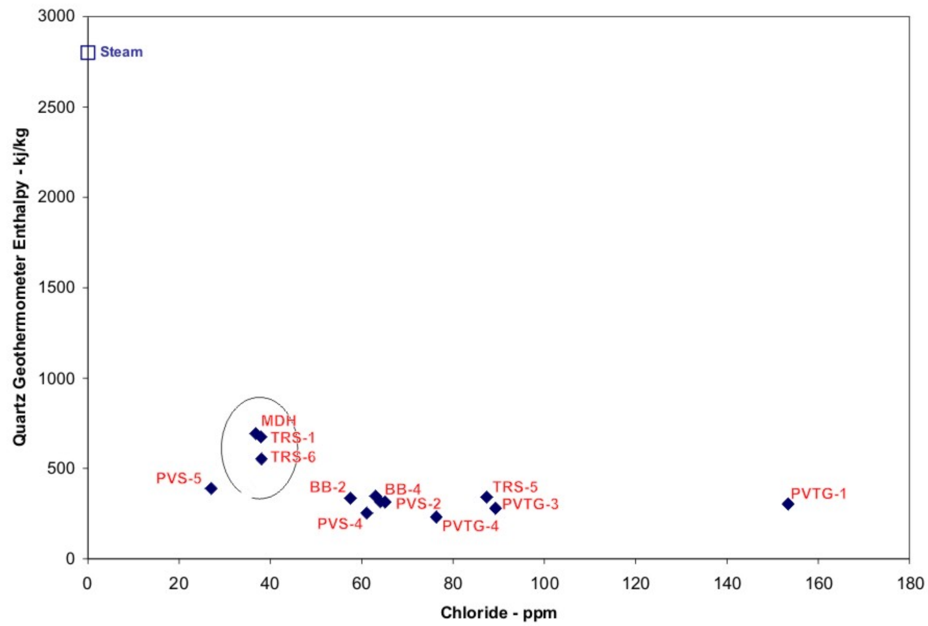


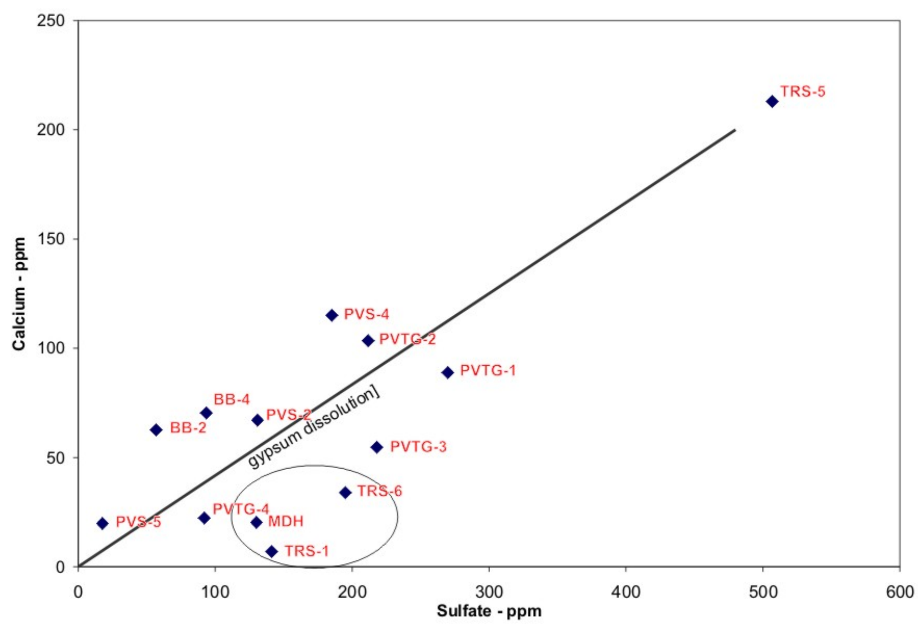
Diagrams: Xkmc and Xkms



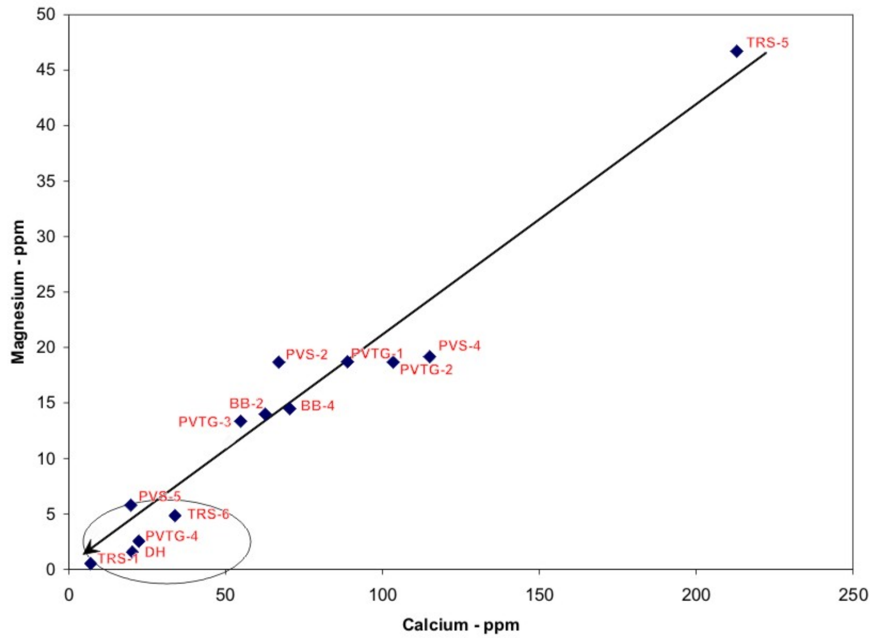


Diagrams: XClHqtz and XSO4Ca





Diagrams: XCaMg and XClSO4



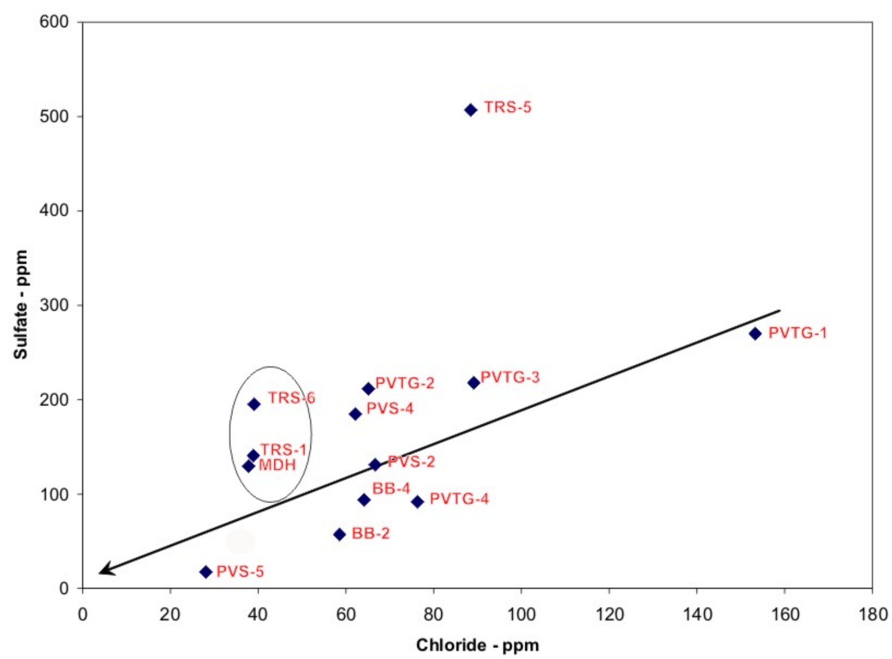


Diagram: SO4-HCO3-Cl

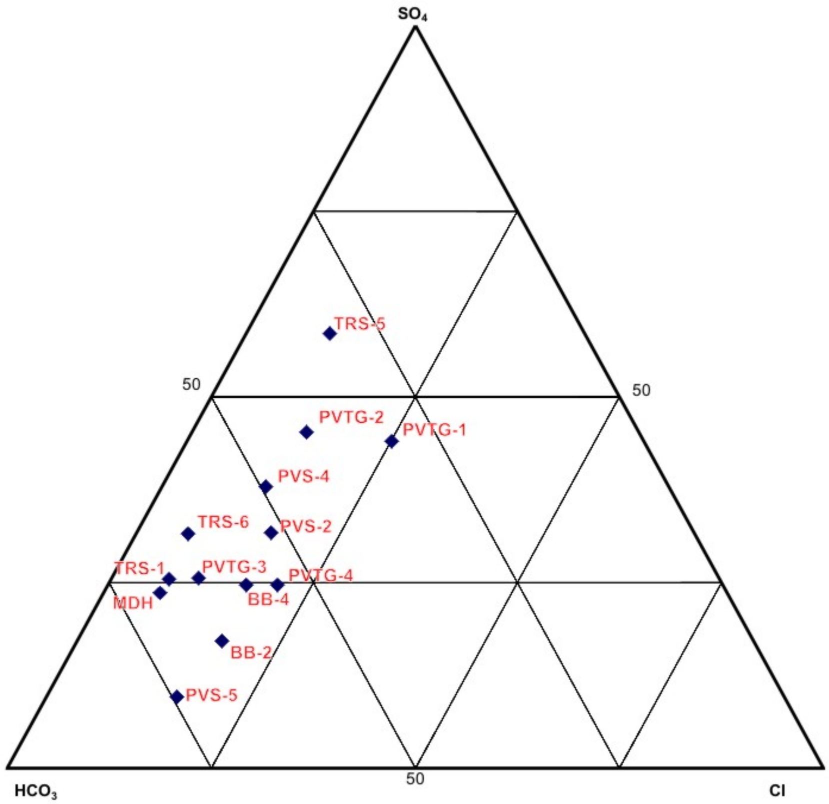


Diagram: Na+K-Ca-Mg