# ELECTRICAL RESISTIVITY SURVEY RESULTS FROM THE ANAHIM VOLCANIC BELT, B.C.

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## ABSTRACT

The Anahim Volcanic Belt is a series of Quaternary and younger volcanic centres lying across British Columbia at about latitude 52°N. Electrical resistivity measurements obtained ahead of the most recent eruptive centre indicate conditions consistent with the presence of geothermal activity.

## THE ANAHIM PROJECT

The Anahim Project consists of a number of regional exploration projects carried out by or supported by the Geological Survey of Canada in the area around the east end of the Anahim Volcanic Belt in south-central British Columbia. These programs include geological, geochemical and geophysical analyses and surveys intended to test for the presence of conditions indicating geothermal activity. The two electrical resistivity programs summarized here were conducted in 1981 and 1982 by the author for the Geological Survey of Canada.

## EXPLORATION PREMISE

The Anahim Volcanic Belt is a series of 37 Quaternary and younger volcanoes lying across British Columbia at about latitude 52°N (Souther, 1977, Bevier et al, 1979). The age of eruptive centres decreases to the east, with a post-glacial eruption at Kostal Lake marking the most easterly event. If the eruptive centres mark the passage of a plate over an upper crustal hot spot, then the present location of the hot spot will be centred near or east of the most recent events.

A hot spot of the magnitude and longevity implied by the track of the Anahim Volcanic Belt may be assumed to be capable of supporting commercial scale geothermal convection systems.

A reasonable search area around and ahead of the latest eruptive events covers in excess of 7500 $km^2$. As is typical of areas such as this with a vigorous rainfall regime, steep slopes and dense vegetative cover, the early visual exploration clues such as steaming ground, hot spring systems and anomalous snow-free areas will rarely occur, and may not be readily observable due to difficult access and terrain conditions.

The purpose of the Anahim Project is therefore to attempt to provide one or more focal points for geothermal exploration within this large unexplored area.

Electrical resistivity was selected as a project component because of its successful application in similar conditions in the Meager Creek Geothermal Area and at the Mt. Cayley Geothermal Project, in southwestern B.C.

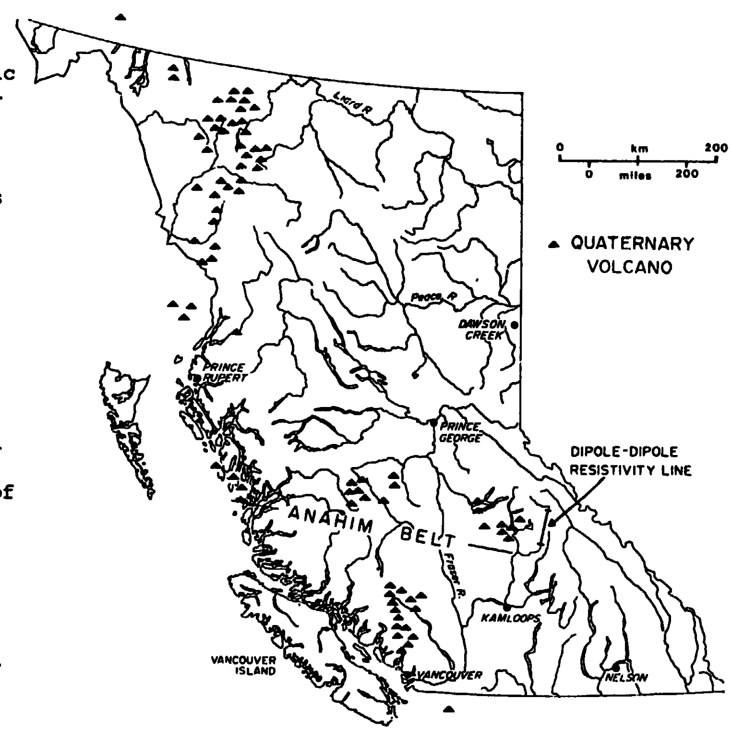



Figure 1 Location of the Anahim Volcanic Belt in British Columbia. The position of the 70 km long dipole-dipole reconnaissance survey line is shown to scale.

ELECTRICAL RESISTIVITY SURVEYS

During a total of 27 operating days in 1981 and 1982 reconnaissance resistivity surveys were undertaken in a north-south corridor crossing the projected strike of the Anahim Volcanic Belt, about 50 kilometres east (ahead) of the most recent eruptive centre. (Schlax & Shore, 1981, Shore, 1983)

A 70 kilometre long dipole-dipole array line was operated along a highway in the valley of the North Thompson River, passing through the town of Blue River, B.C. The valley bottom site provided the only readily accessible continuous line route across the strike of the belt, through an area characterized by vertical relief of over 1800 metres (6000 feet) and very steep slopes. The valley route also provided a penetration advantage, placing the the array at an elevation of less than 770 metres A.M.S.L (2500 feet) throughout the line length.

Using moderate power DC equipment, dipole lengths of 1 and 2 km were used, with dipole separations of n = 1 to 8 and n = 1 to 6 respectively. Theoretical penetration would be of the order of 2 to 4 kilometres in uniform earth.

The dipole-dipole line site was shared with a major fault of 4 km vertical throw (Pell & Simony, 1981) for 40 km distance, a factor expected to impact in some way on the results obtained.

Ten Schlumberger soundings and eleven three-point Schlumberger traverse measurements were obtained in the area in and around the valley survey line. The soundings extended to AB/2 of 1 kilometre, with two of them extending to AB/2 of 2 kilometres. The three-point measurement sites involved Schlumberger array measurements at AB/2 of 250, 500 and 1000 metres. These measurements sample the near surface to a depth of about 200 to 300 metres.

The soundings and three-point measurements were intended to provide extension of dipole-dipole results to surface, and to evaluate the regional background resistivity of the Kaza metasediments away from the influences of the major fault structure. In the course of deploying these background test measurements, some sites were selected in Lempriere Creek, an area west of the main fault in which local rumor indicated hot spring activity occurred.

GEOLOGICAL SETTING FOR RESISTIVITY MEASUREMENTS

The survey area is dominated by two major and regionally pervasive rock units, metasediments of the Kaza group, and Shuswap Metamorphic Complex granite-gneisses (Campbell, 1967). These units contact within the survey area south and west of the town of Blue River. Both represent high resistivity background media of 1000 to 3000 ohm-metres, within which the conductive effects of geothermal alteration and fluid circulation should be readily observable.

This favourable setting is maintained by the presence of glacial and alluvial overburden in most valley bottoms which is also of relatively high resistivity (over 700 ohm-metres). Overburden is often encountered in the area investigations since most of the limited access is located in valley bottoms. Given the limited opportunity to obtain measurements, it is particularly important that overburden not be inherently conductive, so that measurement interpretation remains straightforward.

As well as not interfering, however, resistive overburden plays an active role in enhancing the possibility of discovery in this type of terrain. Steep slopes and a vigorous, year-round rainfall-groundwater regime combine to flush the near-surface and surface slopes of the area, removing any brine leakages from fractures and suppressing surface indications of elevated heat flow. The dense vegetation supported by this rainfall hinders surface prospecting and may obscure from aerial view those surface hot spring manifestations that do manage to establish themselves. The outflow from such a spring in these conditions will likely be undetectable by area resistivity measurements because of the dilution of the brine. Resistive valley overburden can play an important role as an accumulator of low volume brine leakage, presenting a large scale conductive anomaly of up to several square kilometres extent. Chance reconnaissance sampling of a portion of such a conductor can lead to the tracing of the anomaly back to the leakage input point. This is well demonstrated at Meager Creek Geothermal Area where brine accumulation in resistive overburden yields a large area anomaly over 15 times more conductive than surrounding overburden (Shore & Schlax, 1981).

Based on observations to date of background rock and overburden resistivities, it appears that the environment for operating resistivity surveys in the broad area east of the Anahim Volcanic Belt is from an electrical standpoint highly favourable. This is an important factor for an area where data is difficult to obtain physically, and individual results must be relied upon more heavily than in flatter areas with greater data density.

SURVEY RESULTS

The results of the first resistivity surveys in this broad area are summarized in Figure 2.

Two small anomalies were observed in Shuswap granite-gneisses in the southern 15 km of the line. These have not been followed up to date.

South of the town of Blue River, the granite-gneisses contact distinctly with Kaza metasediments which comprise the rest of the exploration area to the north. Here, in 1000 ohm-metre background, a series of 5 broad anomalies lie along the valley. The necessity of operating parallel to the major fault which lies alongside (or under) the line from Blue River northward seriously compromises the interpretability of the data. Current path distortion caused by preferential flow along fault fracture zones and gouge conductors could theoretically account for the full range of observed anomalies. On the other hand, there are zones of higher resistivity and near-surface observations which cast doubt on an all-fault interpretation.

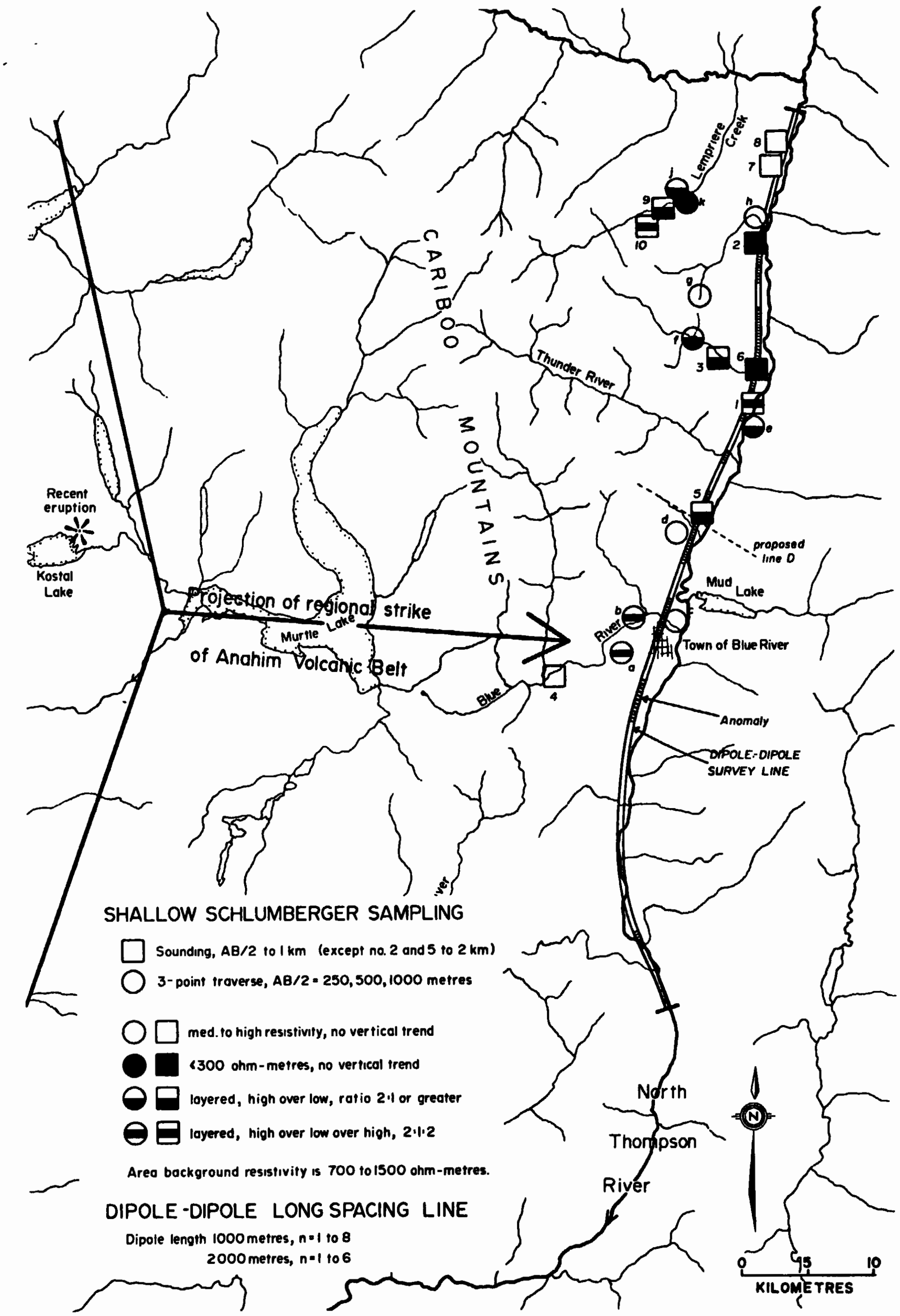



Figure 2 Summary results of resistivity surveys east of the most recent eruption in the Anahim Volcanic Belt.

A detailed dipole-dipole resistivity line (Line D, Figure 2) with dipole spacing of 300 metres was planned for a route across the fault in an anomalous area north of Blue River. This attempt to gain insight into the distribution of conductive zones was postponed when an access bridge washed out in 1982.

At present, the anomalies remain permissive of the presence of large, active geothermal convective systems along the fault zone. The deeply connected fault zone is probably a favourably permeable conduit for localization of thermal fluids. Near-surface sounding # 3 west of the fault supports an anomalous vertical temperature gradient, as does three-point measurement f (Figure 2). The establishment of a thermal cause for the anomalies will require additional data, including direct probing of one or more dipole-dipole anomalies by slim diamond drill hole to measure temperatures.

Reconnaissance measurements away from the fault zone were intended to establish background resistivity values to assist in evaluating the valley line data. Three-point measurements a and b west of the town of Blue River provide weak evidence of possible lateral fluid movement in overburden. Data coverage here is very limited.

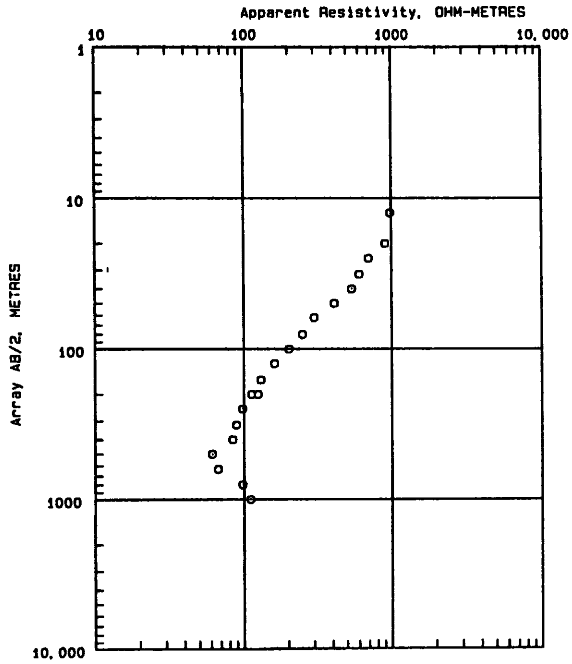
Measurements taken in Lempriere Creek appear to have identified an area of interest distinct from the valley dipole-dipole line. Local rumor indicates hot spring activity somewhere in Lempriere Creek; with this in mind some of the background tests were assigned to the valley, at an arbitrary point about half way up the creek. Sounding # 10 (Figures 2,3) yields a 1-D inversion showing 30 to 50 ohm-metre material lying beneath normal background resistivity of 1000 ohm-metres. Underlying resistive rock suggests that there may be a lateral flow of thermal fluids through the measurement site, from an origin further up the valley. Sounding # 9 supports this model, while implying greater dimensional complexity. The three-point measurements j and k are downstream from the soundings, and indicate extreme conductivities closer to surface, and a laterally complex distribution of conductive material.

The Lempriere measurements are highly anomalous for the region. They may represent detection of an outflow plume from an upstream geothermal source. A thermal origin or present nature for the Lempriere anomalies has not yet been tested.

SUMMARY

The resistivity results from these surveys are one part of a regional geological, geochemical and geophysical investigation of the eastern end of the Anahim Volcanic Belt. The valley dipole-dipole results are permissive of the presence of large-scale geothermal system activity. The temperature regime associated with these anomalies has not yet been tested. The Lempriere Creek anomalous values are typical of geothermal fluid outflow conditions.

These resistivity data alone do not demonstrate the presence of geothermal activity in the area, but the strong and large-scale anomalies are positive indications which should encourage continued exploration and assessment of the area.




Schlumberger Sounding Site # VES- 10

Anahim Project: Blue River Area, B.C.

Figure 3 Sounding # 10 from Lempriere Creek area.

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