# Merging Geological, Seismic Reflection and Magnetotelluric data in the Purcell Anticlinorium, SE British Columbia

*"Test of a Concept to Find Sullivan-Style Deposits"*

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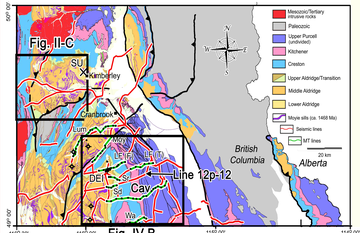
## I. Abstract

Combining geological data, seismic reflection data and magnetotelluric (MT) data in southeastern British Columbia can target concentrations of sulphide mineralization in the subsurface. Existing MT data are being reprocessed with two-dimensional (2D) inversions where possible, and the results are combined with reprocessed seismic reflection profiles and drill hole information. Seismic reflection data acquired for hydrocarbon exploration were initially reprocessed for large-scale regional studies; however, by focusing on the near-surface data, they provide a unique view of the Purcell basin that is not available with any other geological or geophysical data set. A deep (3.477 km) exploration drill hole was drilled by Duncan Energy in 1985 and provides definitive correlations of seismic reflections to stratigraphic horizons along a number of seismic profiles. Thus, the seismic data and drill holes allow detailed mapping of structural and stratigraphic variations, while the MT data help to characterize the electrical properties, and thus perhaps the presence or not of metals, at different stratigraphic levels.

**Figure I-1.** Geological map of southeastern BC. Colored areas represent Proterozoic rocks. Red lines are locations of seismic profiles (Cook and van der Velden, 1995) and green lines with dots represent MT stations (Gupta and Jones, 1995). Outlined areas are enlarged in Figures II-c and IV-B. Seismic Line 12p-12 and MT line Cav are labeled.

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## II. The Concept

***Key properties of the Sullivan deposit***

**Figure II-A.** Cross section of the Sullivan deposit (Freeze. 1966).

Sulphides are in red.

Note the eastward thickenkning into the Sullivan sub-basin. Colors are the same as in Figure I-1. Vp = p-wave velocity and p = density for seismic model in Figure II-B.

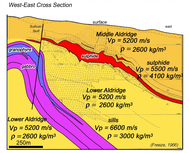



**Figure II-B.** Model of seismic response from the Sullivan deposit.

The section has been extended upward to to include the Middle Aldridge strata and Sundown sill. Colors are the same as in Figure 1. Note the amplitude anomaly associated with the sulphide layer.

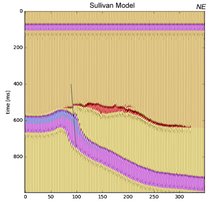
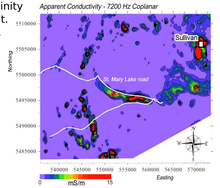



**Figure II-C**. Map of airborne EM anomalies showing apparent conductivity in the vicinity of the Sullivan deposit. (McConnell, D., 1997).

The strong response (red=conductive) indicates that Sullivan-like deposits should be electrically conductive.




***Result: By combining stratigraphy and structure from subsurface data (e.g., seismic) with electrical conductivity, zones with metals may be targeted.***

## III. Data

***An example along seismic line 12***

**Figure III-A.** Line 12p-12 Data - Migrated

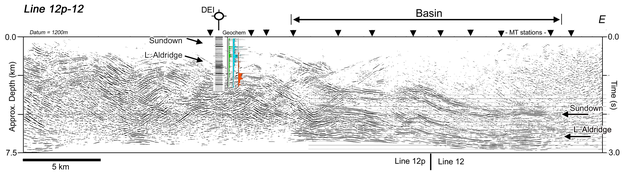



**Figure III-B.** Line 12b-12 interpretation; colors are same as in Figure 1. 'Sullivan horizon' is located between the Sundown and the L. Aldridge. The 'basin' is delineated by mapping the Sundown to L. Aldrdge interval (see IV-B.)

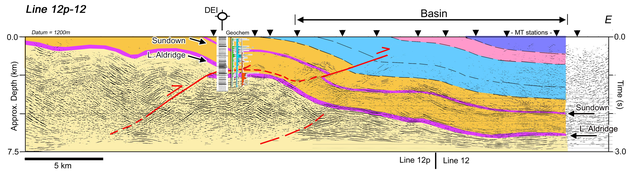
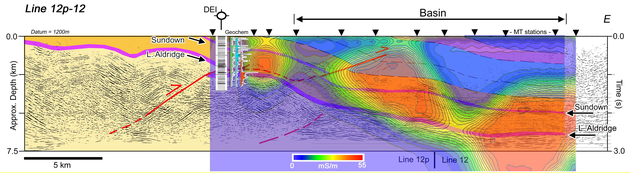



**Figure III-C.** Line 12p-12 Interpretation with preliminary MT Inversion overlay projected into the section. Note: 1) high conductivity (orange) correlated with metals in the drill hole (see Fig. IV-A), 2) high conductivity near fault, and 3) high conductivity in the Sullivan horizon. MT inversion completed by Phoenix Geophysics.




## IV. Results

***Correlating MT with seismic results***

**Figure IV-A.** DEI drill hole. On left are resistivity, reflection coefficient logs, a synthetic seismic trace and interpreted stratigraphy (Cook and Jones, 1995). On the right are geochemical analyses (3m intervals) for Pb, Zn, and Cu (Anderson, 1986; Schulze, 1988). Note elevated Cu in L. Aldridge and elevated Pb, Zn in the M. Aldridge. 'SH' is the Sullivan Horizon.

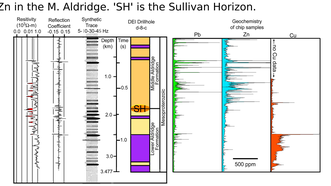



**Figure IV-B.** Map of Sundown to L. Aldridge interval. Thick areas (green-blue) indicate a basin in the same interval as the Sullivan sub-basin. 'CAV' are the MT stations and Line 12 and 12p are labeled.

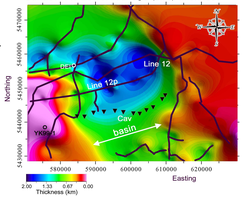
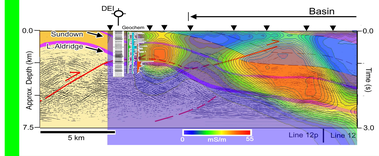



**Figure IV-C.** Enlargement part of line 12p-12 with projected MT inversion. There is good correlation of the western anomaly with metals in the drill hole, as well as high conductivity on the east near a fault that projects to Cu showings in the Creston Fm at surface.




## V. Summary & Conclusions

Merging subsurface stratigraphic and structural variations that are interpreted from seismic reflection profiles with electrical property results determined from inversions of magnetotelluric soundings has provided images of potential targets for metal concentrations in the subsurface of southeastern BC. Along seismic line 12p-12, the projection of the preliminary 2D-MT inversion shows three zones of elevated electrical conductivity that are spatially associated with Middle and Lower Aldridge strata. The easternmost conductor appears to coincide with seismic amplitude anomalies near the Sullivan stratigraphic horizon (Middle Aldridge-Lower Aldridge transition). However, it is too deep (>5km depth) to be of economic interest at this time.

Nevertheless, two anomalous zones that are either entirely or partially located above 2 km may be within target exploration depths. One of these anomalies coincides with metals in the Duncan drill hole and a second is associated with a fault that projects to exposures with copper sulphides in the Creston Formation.

The results demonstrate that combining information from the different geophysical and geological techniques has the potential to detect new target areas for Sullivan-like massive sulphide deposits in the subsurface.

**References:**

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*Cook, F. and van der Velden, A.* 1995, GSA Bulletin
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