



PURCELL GRAVITY ANOMALY--IMPLICATIONS FOR MINERAL EXPLORATION

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KEYWORDS: Purcell anticlinorium, gravity anomaly, Purcell (Belt) Supergroup, Aldridge Formation, new density data, Moyie sills, Sullivan deposit, sedimentary exhalative (SEDEX) deposits.

INTRODUCTION

This study is part of Sedex Mining Corporation's exploration program for Sullivan-type, sedimentary exhalative (SEDEX) massive sulphide deposits in southeastern British Columbia.

PURCELL ANTICLINORIUM

The Purcell anticlinorium is a broad, gently north-plunging structure that is cored by the middle Proterozoic Purcell (Belt) Supergroup and flanked by late Proterozoic Windermere Supergroup rocks in southeastern British Columbia and northwestern United States (Price, 1981). Regionally extensive seismic reflections imaged beneath the anticline in the upper crust correlate with ca. 1468 Ma gabbroic sills (Anderson and Davis, 1995) in the Aldridge formation of the Purcell (Belt) Supergroup. The reflectors define broad folds and thrusts, and support an interpretation that the anticlinorium formed during Mesozoic contraction when imbricate thrust faults carried up to 15 km of Purcell (Belt) and Paleozoic margin sedimentary rocks, and basement in some areas, eastward over a prominent basement ramp (Cook and Van der Velden, 1995).

PURCELL GRAVITY ANOMALY

Combined U.S. Geological Survey and Geological Survey of Canada Bouguer gravity data (no terrain correction applied) define a 50 by 300 km positive gravity anomaly with an amplitude of approximately 20 mgals in southeastern British Columbia and northwestern Montana (Figure 12-1). This anomaly is outlined by the -150 mgal Bouguer gravity contour and shows a steep gradient on the northeast side. The gravity anomaly terminates against the westward projection of the strike of the northern border of the Vulcan Low on the north and against the Lewis-Clark lineament and westward projection of the Sapegoat-Bannatyne lineament on the south (Figure 12-2). This gravity anomaly, here named the Purcell gravity anomaly, appears to core the geographical outline of the Purcell anticlinorium.

NEW DENSITY DATA

Density determinations were made on eighty-six representative samples of rock units in the area to provide better control on the gravity interpretations. Twenty-seven of the density measurements were from core and the remainder on hand-size samples from the field. Results are summarized in Table 12-1.

INTERPRETATION

The Purcell gravity anomaly, which cores the Purcell anticlinorium, is here interpreted to represent a buried complex consisting entirely of Moyie-type intrusions and may represent the location of the rift axis of the Purcell (Belt) basin. Isopachs of the cumulative thickness of Moyie sills and turbidites of the middle Aldridge and unit G, Prichard formation (Höy, Turner and Leitch, 1995) from data by Cressman (1989), Höy (1993) and Turner et. al. (1993), also define a sill injection axis along the core of the Purcell anticlinorium.

IMPLICATIONS FOR MINERAL EXPLORATION

If the Purcell gravity anomaly can be interpreted to identify the location of the incipient phase of Purcell (Belt) basin rifting, the Purcell gravity anomaly may define the limits of hydrothermal systems and sedimentary exhalative (SEDEX) deposits emplaced prior to the Moyie sill event (Anderson and Davis, 1995) in the lower and middle Aldridge formations.

The Sullivan mine and other sedimentary exhalative (SEDEX) occurrences (Kootenay King, Vulcan, Fors and Panda) appear to be positioned along structures that are within or parallel to broad northeast-trending structural zones that cut the Purcell anticlinorium. Höy (1982) defined such a structural zone, which he termed a transverse zone, lying between the Hall Lake and Moyie faults. The zone contained northeast-trending structures, boron (tourmalinite) concentrations and intraformational conglomerate occurrences. The Sullivan mine is located along the central part of this transverse zone. Höy's transverse zone lies along the northern border of the western

Table 12-1. Density data for the Purcell Supergroup samples.

Rock Type	Host Unit	Number of measurements	Range (g/cm ³)	Mean Density
Moyie Sills	M-A	14	2.85-3.14	2.97
Moyie Sills	L-A	8	2.87-3.02	2.96
Moyie Dikes	M-A	3	2.98-3.02	3.00
All Moyie Intrusives	M-L-A	25	2.85-3.14	2.97
Quartzites	M-A	5	2.69-2.74	2.73
Quartzites	L-A	12	2.66-2.83	2.73
Argillites	U-A	1	2.79	2.79
Argillites	M-A	9	2.67-2.79	2.74
Siltstones	M-A	2	2.55-2.57	2.56
Siltstones	L-A	3	2.73-2.80	2.76
Schists	L-A	7	2.63-2.84	2.78
Fragmental Rocks	M-A	5	2.67-2.72	2.70
Laramide Intrusives	M-A	3	2.60-2.73	2.67
Cambrian Intrusives	M-A	3	2.57-2.62	2.60
Granophyres	L-A	2	2.66-2.71	2.69
Lamprophyres	L-M-A	3	2.91-2.94	2.92
Hellroaring Intrusives	M-A	4	2.60-2.65	2.63
Massive Sulphide	L-M-A	2	4.14-4.20	4.17

A = Aldridge Formation, L = lower, M = middle, U = upper.

projection of the Vulcan Low (Figure 12-2), as defined by Clowes et. al. (1997). By analogy, the western projection of the southern boundary should also be considered a highly prospective area for sedex-type mineralization. Are there other Vulcan Low-type continental structures that control mineralization along the Purcell (Belt) basin? Detailed gravity surveys may be a useful tool to locate and define other northeast transverse zones or rift axis offsets within the basin. Such studies may provide new exploration targets.

ACKNOWLEDGMENTS

The author thanks Derek Brown, Trygve Höy and Bill McMillan (B.C. Geological Survey Branch), Carmel Lowe (GSC-Sidney) and Fred Cook (U. of Calgary) for their comments. The interpretations are entirely the author's.

Figure 12-1 is a plot of 11,638 U.S. Geological Survey records and 904 Geological Survey of Canada records. The Canadian gravity data is available from the Geophysical data Centre (fdostaler@gsc,NRCan.gc.ca) at \$0.01CND/point and the USA gravity data is available from NOAA/National Geophysical Data Center (info@ngdc.noaa.gov) for approximately \$200 USD. Surfer for Windows (www.golden.com) software was

used for data reduction. Data is presented as simple Bouguer gravity values without terrain corrections.

REFERENCES CITED

- Anderson, H.E. and Davis, D.W. (1995): U-Pb geochronology of the Moyie sills, Purcell Supergroup, southeastern British Columbia: implications for the Mesoproterozoic geological history of the Purcell (Belt) basin, *Can. J. Earth Sci.* 32, p. 1180-1193.
- Clowes, R., Hammer, P., Mandler, H., Ross, G., Cook, F., Eaton, D. (1997): The Vulcan Low, Matzhiwin High and related domains as revealed by SALT 95 reflection data; in Ross, G.M., (compiler), *1997 Alberta Basement Transects Workshop*, Lithoprobe Report #59, Lithoprobe Secretariat, University of British Columbia, p. 15-22.
- Cook, F.A. and van der Velden, A.J. (1995): Three-dimensional crustal structure of the Purcell anticlinorium in the Cordillera of southwestern Canada; *Geological Society of America Bulletin*, v. 107, p. 642-664.

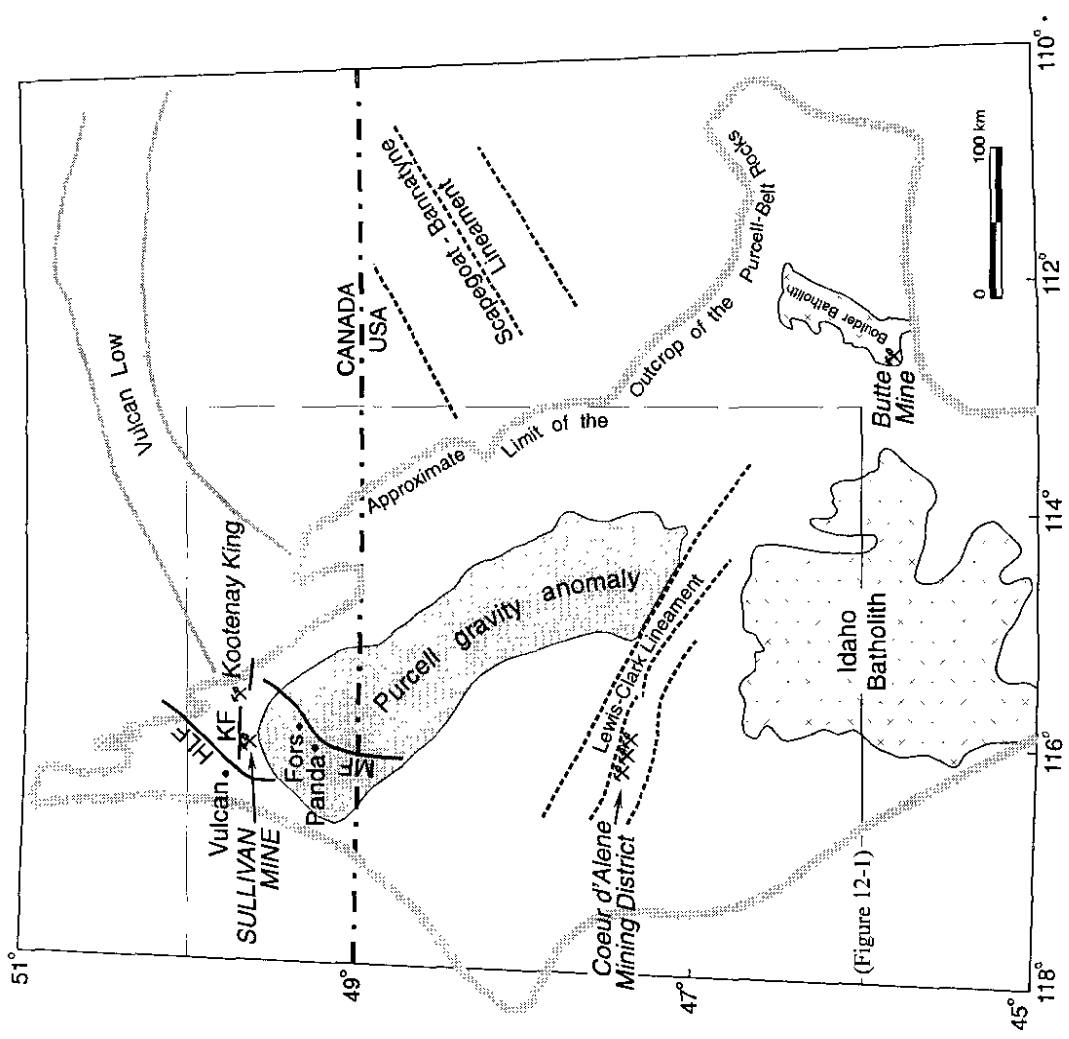


Figure 2. Map showing location of Purcell gravity anomaly and regional structures. Abbreviations are as follows: HLF, Hall Lake fault; MF, Moyie fault; and KF, Kimberley fault. The location of the Purcell gravity anomaly is outlined in grey.

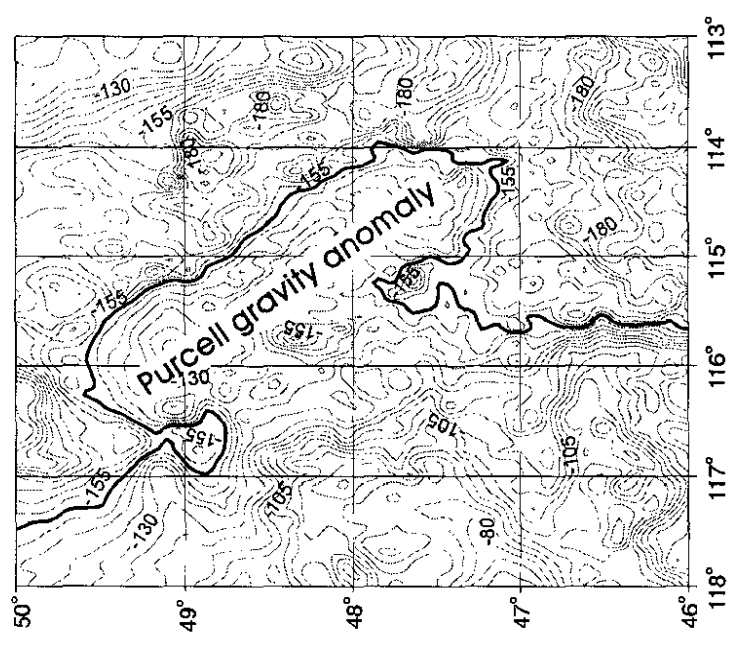


Figure 1. Simple Bouguer gravity anomaly map for part of the Purcell anticlinorium. 12,542 stations from U.S. Geological Survey and Geological Survey of Canada records.

- Cressman, E.R. (1989): Reconnaissance Stratigraphy of the Prichard Formation (Middle Proterozoic) and the Early Development of the Belt Basin, Washington, Idaho and Montana; *U.S. Geological Survey, Professional Paper* 1490.
- Höy, T. (1982a): Stratigraphic and Structural Setting of Stratabound Lead-Zinc Deposits in Southeastern B.C.; *Canadian Institute of Mining and Metallurgy, Bulletin* 75, Number 80, p. 114-134.
- Höy, T. (1982b): The Purcell Supergroup in Southern British Columbia; Sedimentation, Tectonics and Stratiform Lead-Zinc Deposits; *in Precambrian Sulphide Deposits, H.S. Robinson Memorial Volume, Hutchinson, R.W., Spence, D.D. and Franklin, J.M., Editors, Geological Association of Canada, Special Paper* 25.
- Höy, T. (1993): Geology of the Purcell Supergroup in the Fernie West-half map area, Southeastern British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources, Bulletin* 84, 157p.
- Höy, T., Turner, R.J.W., Leitch, C.H.B., Anderson, D., Ransom, P.W., Pighin, D. and Brown, D. (1995): Depositional Environment, Alteration and Associated Magmatism, Sullivan and Related Massive Sulphide Deposits, Southeastern B.C.; A1: Field Trip Guidebook, Victoria '95, GAC/MAC Annual Meeting—May 17-19, 1995, p. 6-7.
- Price, R.A. (1981): The Cordilleran Foreland Thrust and Fold Belt in the Southern Canadian Cordillera; *in Thrust and Nappe Tectonics, McClay, K.R. and Price, N.J., Editors, Geological Society of London, Special Publication* 9, p. 427-448.
- Turner, R.W., Höy, T., Leitch, C.H.B., Anderson, D. and Ransom, P.W. (1993): Guide to the Geological Setting of the Middle Proterozoic Sullivan Sediment-hosted Pb-Zn Deposit, Southeastern British Columbia; *in Link, P.K., Editor, Geologic Guidebook to the Belt-Purcell Supergroup, Glacier National Park and Vicinity, Montana and Adjacent Canada; Belt Symposium III Fieldtrip Guidebook, Belt Association Inc., Spokane, Washington, p. 53-94.*