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rich and contain liquid, vapour and daughter minerals of halite, sylvite with or without calcite, hematite or an opaque phase. At Bell, the dominant inclusion type contains liquid, vapour and halite. Some vapour-rich inclusions are present in both deposits, which suggests that the fluids boiled at times. Inclusions at Granisle homogenize largely by vapour disappearance at temperatures between 240 and 1300 degrees C, with two maxima at 480 and 1050 degrees C. Inclusions at Bell homogenize largely by halite disappearance (after vapour disappearance) at temperatures from 310 to over 700 degrees C, with most filling at about 530 degrees C. The inclusion fluids at Granisle have salinities of up to 73% NaCl plus KCl, whereas those at Bell have salinities of 33 to 58% NaCl and less than 10% KCl. These observations indicate that Granisle mineralization took place at near-magmatic temperatures and that Bell mineralization took place at sub-magmatic temperatures from a solution saturated with halite and much more saline than the meteoric water which is thought to have formed the sericite overprint.

Paper No. 134 — 3:30 p.m.
Origin of the Sustut Copper Deposit, Central British Columbia.
D. H. WILTON and A. J. SINCLAIR, University of British Columbia, Vancouver, B.C.

The Sustut copper deposit is in central British Columbia, about 370 km northwest of Prince George. Copper concentrations are in the Upper Triassic Moosevale Formation, mainly in gently dipping tabular zones parallel to bedding and much less abundantly in cross-cutting veinlets that occur in local concentrations and with local preferred orientations. Copper-rich zones with economic potential appear to be restricted to a zone of about 200 m within the 700-m-thick, coarse-grained volcaniclastic host, although there are minor occurrences throughout. Copper minerals (chalcopyrite, bornite, chalcocite and native copper) and gangue (epidote, quartz and calcite) are common to both veins and tabular zones, although proportions of these minerals vary drastically from place to place. Some detailed textural features, especially bornite-chalcopyrite intergrowths, are also common to both veins and tabular zones. Veinlets are predominantly open space filling, whereas tabular zones are a combination of open space filling and replacement, commonly with replacement dominant.

Tabular zones and local sets of veinlets appear to have formed an interconnected system permeable to ore fluids, presumably derived from below. Comparable veins are reported in underlying Triassic lavas. Thus, veinlets form an integral part of the mineralizing system and become an important evaluation criterion in exploration. Age of mineralization is uncertain, but vertical mafic dykes that cut the Savage Mountain Formation stratigraphically above the main mineralized zones are pre-mineralization.

Logging of 10,000 feet of drill core representing several cross sections through the main copper-rich zones was done in a thorough and rigorous manner on a coding form designed for input into a computer. This procedure, combined with various forms of computer output, led to a rapid visual and quantitative evaluation of the data, particularly as regards internal stratigraphy of the volcaniclastic country rock, mineral zoning and the relationship of copper concentrations to wall rock with particular characteristics. In brief: (1) local internal stratigraphy is shown best by layers of sand-sized volcaniclastic rocks; (2) an ideal vertical zoning from margin to core in a tabular zone is pyrite-chalcopyrite-bornite-chalcocite - native copper, with much overlap of mineral zones and, in places, the absence of symmetry about the core; and (3) copper minerals statistically are much more prevalent in agglomeratic rocks that are dominantly green (i.e. iron in the reduced state) rather than red.

Paper No. 135 — 4:00 p.m. 092J/3W
Mineral Deposits in the Callaghan Creek Area, Southwestern B.C.
J. H. L. MILLER, A. J. SINCLAIR and D. WETHERELL, University of British Columbia, Vancouver, B.C., and A. H. MANIFOLD, British Columbia Institute of Technology, Burnaby, B.C.

Polymetallic sulphide deposits in the Callaghan Creek area of southwestern British Columbia occur in a roof pendant of pyroclastic rocks surrounded by various masses of the Coast Plutonic Complex. These coarse-grained pyroclastic rocks are divisible into five easily mappable units of rhyolitic to andesitic composition. The units dip steeply to the east, strike northerly or slightly west of northerly, and appear to form a homoclinal succession with tops to the east. The sequence has been correlated tentatively with the Gambier Group (Cretaceous) by others on the basis of general lithologic similarities with type sections of the Gambier rocks to the south. A crystal tuff unit in the sequence has been cut by what are thought to be genetically related hornblende-rich dykes for which a single K-Ar date on hornblende is 124 plus or minus 4 m.y.

Seven mineral occurrences are known, two of which, the Warman and Manifold zones, are in production by Northair Mines Ltd. Minor production has come from two of the more southerly occurrences, the "Millsite" and Silver Tunnel zones of Van Silver Explorations Ltd. (now defunct). Known occurrences are confined to the lowermost unit (acidic) and the uppermost unit (intermediate).

At least four of the known occurrences show various textural indications that a significant proportion of the sulphide might have concentrated prior to regional metamorphism (greenschist facies) and emplacement of Coast Plutonic rocks. An apparent stratigraphic control to some occurrences, their localization in a thick acidic to intermediate pyroclastic sequence and local intercalations with chemical sedimentary rocks (carbonate and chert) combine with textural and assay data to suggest that these occurrences are volcanogenic in origin, but have suffered considerable mobilization during subsequent metamorphism.

Some of the ore zones of Northair Mines are narrow and consist of several small veins filled mainly with quartz and/or calcite and small amounts of sulphides (mainly galena, sphalerite and pyrite), all of which are post-deformation in age. Similar, but non-sulphide-bearing, veins occur elsewhere on the property and presumably are related to metamorphism of the pyroclastic sequence and/or associated plutonism. We speculate that sulphides in such veinlets have been derived from nearby, pre-existing sulphides.

Consequently, small veinlets containing minor proportions of sulphides may well represent an important exploration parameter in this and other pendants within the Coast Plutonic Complex.

Paper No. 136 — 4:30 p.m.
Oil and Gas Potential of Canadian Frontiers.
C. R. EVANS, Imperial Oil Limited, Calgary, Alta.

Reconnaissance exploratfon of Canada's eastern and northern frontiers began some ten or twelve years ago. To date, significant gas discoveries have been made in three areas: the Beaufort Basin, the Sverdrup Basin and the Continental Shelf off the coast of Labrador. Oil has also been discovered in the Beaufort Sea and Arctic Islands, but in volumes of questionable economic size.

For a multitude of reasons, different segments of our society require estimates of what is there, what is economically recoverable and the timing of potential production. No single estimate of these three unknowns is or can be appropriate for the different types of decisions that must be mede.

A probabilistic approach to these unknowns is less intellectually satisfying, but far more useful and meaningful, than a single number at this stage of frontier exploration.

(3) MECHANICAL-ELECTRICAL DIVISION, Mining Methods and Equipment, Hyatt Regency Plaza East, with D. PURDIE and E. MITCHELL, Session Chairmen.

Paper No. 137 — 2:30 p.m.
Retarding Systems for Electric-Drive Haulage Trucks.
B. J. TURLEY, General Electric Co., Erie, Pa.

The paper deals with the following topics:
What is Dynamic Retarding?;
Function of Dynamic Retarders;
Application Considerations;
Importance of Dynamic Response;
Recent Improvements in Retarder Systems.

Paper No. 138 — 3:00 p.m.
M/E Aspects of Kaiser Resources Limited's Newly Developed Underground-to-Surface Coal Slurry Pumping System.
A. W. GRIMLEY, N. PEASE and B. HART, Kaiser Resources Limited, Sparwood, B.C.

Hydraulic mining, the relatively new, extremely productive and safe mining system pioneered by Kaiser Resources Ltd. at their underground mines in British Columbia, is taking another step forward to help widen its applicability to varying conditions.

This joint paper gives up-to-date information on the new U/G dewatering and pumping complex, generally known as Panel 6, with emphasis on mechanical and electrical aspects.

Panel 6 is a completely new mine situated adjacent to earlier underground mines in the Sparwood Ridge area in general. It is designed to produce 1.3 million tons of coal per year for approximately 15 years starting in mid-1979, and will consist of basically a single monitor operation together with its associated mining equipment, a diesel-powered monorail supply system, a highly efficient communications network and, last but not least, a specially designed and prototype underground dewatering and pumping system.

This system consists of 2 double-deck vibrating screens which dewater the minus 8- plus 3/8-in. material discharging into a 150-ton bin, from which a chain conveyor feeds onto a 36-inch conveyor transporting the coal to the surface.

The -3/8-inch material and water report to a 186,000-gallon sump which is simply an excavation in the rock with a concrete dam at each end. From this point, there are two separate slurry pumping systems. Each system (or train) consists of 3 pumps connected in series and an installed spare. Once slurry flow is established, a nuclear density controller automatically maintains a pre-set specific gravity. Each train is capable of pumping 3240 gpm to the surface dewatering facility. Relief in case of emergencies or unscheduled shutdown of the underground dewatering system is provided for by a 300,000-gallon