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Conference Reports

Geomorphology of the Canadian Cordillera and its Bearing on Mineral Deposits

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Geomorphology of the Canadian Cordillera was chosen as the theme for the annual symposium of the Cordilleran Section of the Geological Association of Canada, held February 6 and 7 in Vancouver. The meeting attracted 530 registrants. Thirty eight invited papers were scheduled in six sessions in an attempt to integrate the following disciplines: geomorphology, Quaternary geology, physical geography, engineering geology, pedology, and mineral exploration. Two major sessions on geomorphology were designed to appeal to all and comments indicate the success of this approach.

The symposium opened with seven background papers concerned primarily with geomorphology. In the opening paper O. Slaymaker stated that earlier classifications of physiographic divisions were based on topography primarily whereas he felt that physiographic divisions should be based primarily on geomorphic processes. W. H. Mathews discussed the late Tertiary paleogeomorphology of the Cordillera and indicated the role it has played in the development of the present day topography. He felt that most geologists had an attitude of benign neglect with regards to Tertiary geology. He stated the economic importance of the Tertiary is seldom referred to notwithstanding major placer and coal deposits of this age. G. E. Rouse enlarged on Mathews' theme by reconstructing from paleobotanical evidence the climatic changes in the Cordillera during the past 50 million years. He showed that in early Tertiary we had a tropical climate and that by the end of the Tertiary the climate had cooled to temperate to be followed by an arctic climate in part of the Pleistocene.

R. P. Goldthwait outlined the broad principles of Cordilleran glaciation and indicated that most of our present day landscapes owe their origin to, or were modified by glaciation. He suggested the possibility of 22 glaciations based on the marine record during Pleistocene time, commencing more than three million years ago, however in the Cordillera evidence of most of the older glaciations is obliterated by the youngest glaciation during Wisconsin time (10,000 - 100,000? years ago). The temperature was probably depressed by 7° to 11°C at the peak of each glaciation. Goldthwait also stated that in the deep valleys in the Cordillera the ice flowed at upwards of 100 times the rate of flow in the uplands, and also that during many glaciations the ice was primarily in the valleys leaving refugiums in other areas. A paper by G. Plafker and W. O. Addicott proposed extensive glaciation characterized by glaciomarine deposits in the Miocene of southeast Alaska and that similar conditions extended through the Pliocene and Pleistocene to the present day. Goldthwait also discussed neoglaciation and N. F. Alley enlarged on this subject indicating that neoglacial deposits are probably widespread in the Cordillera but up to date poorly investigated. He also concluded that the climate was warmer during deglaciation than at present.

M. Church discussed river morphology in the Cordillera stating that the governing factors are physiography and geological materials, geomorphological history, and hydroclimatology and he outlined the types of river and deposits to be expected as these factors varied.

Eight papers given by J. E. Armstrong, D. J. Easterbrook, S. C. Porter, June M. Ryder, R. J. Fulton, J. J. Clague, O. L. Hughes and J. T. Andrews outlined the Quaternary chronology and stratigraphy of northwestern Washington State, British Columbia east of the Rocky Mountains and the Yukon Territory. All speakers demonstrated that only the Wisconsin glaciation is well documented in the northwest Cordillera and that the late Wisconsin glacial deposits are the best understood. The last major ice advance took place between 10,000 and 20,000 years B.P. Prior to the last major glaciation most of the Cordillera was ice free. According to Easterbrook this period lasted about 10,000 years, but Fulton and Hughes suggested it lasted about 30,000 years and Armstrong thought it may have lasted 40,000 or more years. More work will need to be done before the overall picture is clear. Armstrong, Easterbrook, Fulton, Hughes, Clague, and Porter all referred to earlier Wisconsin glaciations and nonglacial intervals and Porter suggested that nonglacial deposits in the Cascade Mountains of Washington State may antedate the Bruhnes-Matuyama boundary (ca. 700,000 years). Armstrong, Easterbrook and

Andrews all described late Wisconsin (10,500 - 13,000 years B.P.) glaciomarine deposits along the Pacific coast and related them to relative sea-level changes reaching 200 m in places resulting from isostatic and eustatic adjustments.

Two papers on land-use classification were presented by A. N. Boydell and J. Horcoff, the former speaking on an all purpose terrain classification and the latter on terrain classification in relation to highway engineering. Both systems of classification emphasized geomorphology; however, Boydell stressed the genetic origin of the materials involved, whereas Horcoff stressed the texture of the materials and their engineering properties. H. Nasmith stated that geomorphological studies provided the engineer with three main benefits, namely: - 1) a preliminary geological map of the materials at or near the site; 2) a basis for the planning of subsurface investigations; and 3) a basis for interpreting the results of the investigation. He warned that geologists and engineers should not base too many conclusions on geomorphological studies without augmenting them with detailed soils engineering studies.

G. Eisbacher classified large rock slides, which are common in the Cordillera, in two main types: - 1) slow deep-seated mountain ruptures, and 2) post-glacial debris streams. He referred to the classic work of A. Heim and O. Ampferer in the Alps. He also stated that the structural geologist has a most important role to play in the study of deep-seated mountain ruptures and the mapping of potentially unstable bedrock areas. D. Piteau and F. Patton both discussed mass wasting in specific areas. Patton described the catastrophic slide in 1975, with the loss of four lives, near Pemberton, B.C. The slide, which moved 29 million cubic metres of volcanic rock and ice seven km in a matter of minutes consisted of two phases: the first a debris flow or avalanche and the second a mudflow. He stated that the area had undergone previous slides of the same magnitude. Piteau outlined studies for a 68 mile stretch of the Fraser Canyon, which is subject to many rockfalls, landslides, debris slides, avalanches and washouts and concluded that 66 per cent of all such incidents occur opposite alluvial fans or river directional changes. At a luncheon address R. F. Legget outlined the environmental problems resulting from the encroachment of civilization into the mountain regions and on river floodplains. Piteau, Patton, Legget, and Eisbacher all felt that as civilization spreads into the mountains the geologist and engineer have an ever increasing role in bringing to the attention of the public the hazards of such living and the need to plan most carefully in advance. Only with this help will man be able to live in harmony with the physical environment. Another paper dealing with environmental hazards was given by D. R. Crandell and dealt with dormant and active volcanoes of the northwest Pacific. He concluded that the low frequency of volcanic events, that is lava flows, pyroclastic flows, and mudflows suggests the overall risk of living near volcanoes is low compared to the risk from other kinds of natural phenomena in the Cordillera, for example flooding, rockslides and earthquakes. However he stated that land-use planning decisions made now may be with us for centuries therefore in planning hydroelectric developments, nuclear power plants, and communities these volcanic hazards should be taken into account even if the frequency of a volcanic hazard is as low as in once in 2,000 years. In the various discussions of geological hazards two quotes stood out: - 1) society exists with the consent of geology, and 2) the present is the key to the future.

L. M. Lavkulitch discussed the role of geomorphology in pedological studies stating that most pedologists realize that distribution and development of soils are closely related to geomorphic surfaces both as to the shape of the surface and the composition of materials. He stated that in all geomorphological studies, and in particular correlation studies it is essential that geologic events and processes be integrated with evidence from pedology, knowledge of past climate trends, palynology, and tephrachronology. He also emphasized the role of stratigraphy in pedological studies.

C. Pharo and D. Tiffin discussed the topography and post-bedrock sediments in the Strait of Georgia and on the continental shelf off Vancouver Island. Tiffin stated that the average depth of water on the continental shelf is 200 m, whereas Pharo noted that in the Strait of Georgia it is 400 m deep in places and at the mouth of some fiords reaches 700 m. The overdeepening of the Strait is explained by glaciation. Most of the Strait has thick deposits, up to 500 m, of Holocene and Pleistocene sediments overlying bedrock. Tiffin finds that the continental shelf off northern Vancouver Island shows little evidence of glacial and younger sediments overlying the Tertiary bedrock. The shelf off southern Vancouver Island, however, especially opposite Puget Sound, provides ample evidence of glaciation with episodes of scour and fill and deposition of Pleistocene and younger sediments.

Several papers were presented in an endeavour to show how geomorphological studies could aid in mineral exploration. R. W. Boyle discussed gold placer deposits and classified them as eluvial, alluvial, aeolian, and beach in which gold is respectively concentrated by the forces of gravity, running water, wind and waves. J. A. Greig described both eluvial and alluvial gold placer deposits in the unglaciated Ladue River area of the Yukon Territory. W. W. Shilts outlined a mineral exploration program based on geochemical analyses of till and showed that in glaciated areas, which includes nearly all of Canada, this procedure is normally more reliable than sampling stream sediments. Reconnaissance sampling aims at indentifying the dispersal tails of potential mineral deposits based on known ice flow history. K. Fletcher stated that traditionally stream sediments have been preferred for reconnaissance geochemical surveys but in some areas of the Cordillera, particularly the Interior Plateaus other media might be more suitable. He found that in the Rayfield River area lake sediments and dispersion trains of Cu-rich syenite also proved to be suitable. S. J. Hoffman found that samples from cirques and U and V shaped valleys in central British Columbia have shown that talus fine samples are more successful in outlining mineral occurrences than drainage sediment samples. P. M. Bradshaw stated that the nature of the overburden dictates which exploration geochemical techniques should be used or indeed whether or not geochemistry should be used. Curtin *et al.* used a multiple sampling approach in

geochemical exploration in permafrost terrain of the Yukon - Tanana Upland of Alaska and analyzed five sample media: - 1) panned concentrates, 2) the clastic, minus-80-mesh stream sediment, 3) the oxalic-acid-leachable fraction of the stream sediment, 4) the stream bank sod, and 5) aquatic bryophytes. The last three media act as scavenging agents of ions in stream waters. The results indicate that these scavenging agents delineate mineral potential areas better than the stream sediments although panned concentrates also produced good results. It is obvious that in order to conduct the most useful and productive type of geochemical exploration, a thorough knowledge of the physiography and the overburden is desirable, and this again stresses the need for close cooperation between the exploration geologist, geochemist, and geomorphologist.

C. Godwin discussed supergene enrichment of a copper-molybdenum deposit in the Yukon Territory stressing its uniqueness as it is the only known example in the Canadian Cordillera of leached capping and a supergene enrichment zone that was neither modified by glaciation nor preserved by burial under younger rocks. Finally three papers were delivered dealing with uranium deposits. Although the relation to geomorphology at first glance seems tenuous all three speakers, H. R. Wynne-Edwards, Frank Armstrong and K. Tapaninen related uranium deposits to palaeosurfaces which are paleogeomorphological landforms.

In conclusion, one might state that the symposium was eminently successful in its aims: - 1) to create a better understanding among those working in widely varied earth science disciplines and to demonstrate that all had knowledge to gain and dispense and 2) to demonstrate the advantages of integrated studies resulting in maximum gains to society.

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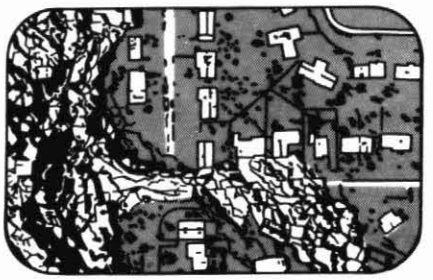

Environmental Earth Sciences and Engineering

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The Fourth Annual Conference of Environmental Earth Sciences Divison of the GAC again sponsored this informal meeting of Central Canada geologists, engineers, environmental scientists and other interested professionals. As in previous years, the conference was ably arranged by a volunteer, this year by W. R. Cowan and his associates at the Ontario Ministry of Natural Resources.

The meeting held on November 29, 1975 in the Ontario Room at Queen's Park was attended by some 120 registrants.

Following opening remarks by E. G. Pye, Director of the Geological Branch of the Ministry of Natural Resources, eight papers, each of one-half hour in length, including discussions were presented.

Q. H. J. Gwyn of the Ministry of Natural Resources, Division of Mines, outlined studies carried out in 1975 on the Champlain Sea Clays in the Hawkesbury area. Dr. Gwyn, who had previously mapped the quaternary geology of the area, carried out an eight hole drilling programme which included some 600 feet of boring, 122 in situ shear strength measurements and the collection of 122 samples in thin wall Shelby tubes. The samples were examined by R. M. Quigley and J. E. Haynes at the University of Western Ontario to assess the variability of the engineering properties, pore water chemistry and clay minerology, It was determined that the sediments showed preconsolidation and less variability in their properties than has been reported in other studies. Further studies will compare the characteristics of these clays with those of other areas where retrogressive failures have occurred.

J. S. Gardner, Department of Geography, University of Waterloo, described the geomorphic impacts of the 1974 Grand River (Ontario) flood which had a magnitude with a recurrence interval of about once in 500 years and had catastrophic property damage effects. Gardner found that, insofar as landform modification and the creation of obvious features are concerned, the flood had relatively minor effects. Large amounts of fine sediment were undoubtedly carried in suspension, however, the steep stream and flood-plain gradient prevented deposition in the studied area. Small scale features such as chutes, scour pits, chute bars and splay deposits were observed throughout the affected area; however, the major geomorphic effects were associated with man-made structures and related flood-plain modifications.

Following this description of the effects of a major flood, E. F. Anderson, Ministry of Natural Resources, Ontario, outlined government criteria for the designation of hazard lands. These lands defined as susceptible to flooding or erosion, instable or hazardous because of other conditions, when identified, are included in all official plans as a designated land use with appropriate developmental control policies. The emphasis, according to Mr. Anderson, is on the prevention of development of hazard lands since the costs of remedial measures to overcome damage usually exceed the opportunity lost through regulation or prohibition of development.

C. J. Acton, Head of the Ontario Soil Survey summarized the programme of the survey which involves both soil inventory and research studies. The inventories, Acton outlined, are intended to document the nature, extent and distribution of the soil resources of the province to provide a basis for land-use decision making. Research activities are aimed at extending the usefulness of this resource information for agricultural as well as non-agricultural purposes. Some of the present research involves