CARIBOO - BELL

Mt Polley

885567

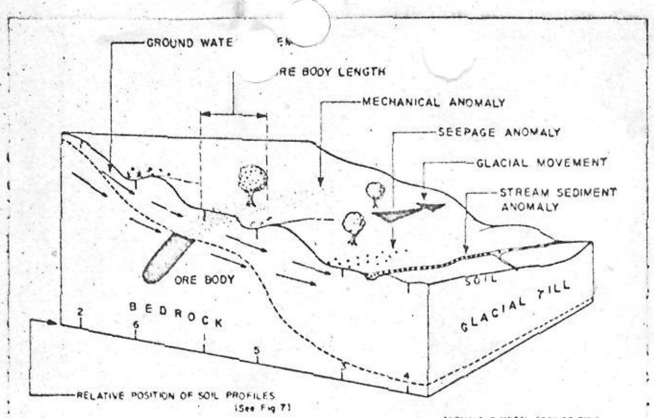
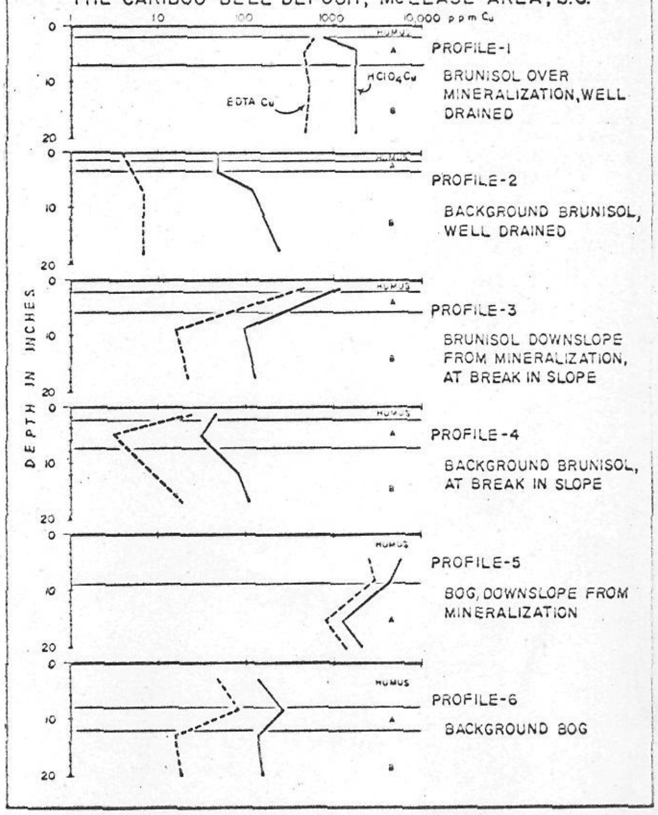


FIG.2 IDEALIZED PROFILE.
GEOCHEMICAL ANOMALIES IN AN ALPINE GLACIATED AREA, YOUTHFUL TOPOGRAPHY

Six profiles located over the Cariboo-Bell deposit in the McLease Lake area of British Columbia are shown in Figure 7. The relative positions of these profiles are shown in Figure 2, the idealized profile for Alpine glaciated areas. The six profiles form three pairs of anomalous and background profiles from three different situations; well drained soil on a slope, soil at the break of slope, and material from boggy ground. All the background samples are characterized by having no values above 300 ppm while the profiles affected by mineralization are generally above 1000 ppm. Profile 1 collected from well-drained soil over mineralization shows a uniform level of copper content with depth in the mineral soil, while the uppermost A horizon is slightly lower. It is however anomalous throughout its depth and this uniformity in itself is a good indication that mineralization lies directly below the sampling point (compare for example profiles 3 and 5). The metal is approximately 20-25% cold extractable except in the mineral soil, while in the organic rich A horizon it is approximately 70% cold extractable. This is typical of the proportion of cold extractable metal which can be expected from dispersion of anomalous material directly over mineralization by a combination of residual and mechanical means in an area such as this. The equivalent background profile (Profile 2) is not anomalous throughout its depth and shows five to ten percent cold extractable metal. Profile 3 is collected 2,000 feet downslope from the known mineralization at the break in slope where some seepage or spring water can be expected but bog conditions are not encountered. The total metal concentration decreases very sharply with depth by a factor of ten, falling into the background range below a depth of approximately 8 inches. (This diagram is also a very good illustration of the importance of collecting from the correct soil horizon during a soil sampling programme as the difference in concentration between the two samples from a depth of 4 and 8 inches is 350 ppm and 0 and 8 inches is 1500 ppm). Within the anomalous portion of the profile, the cold extractable metal is 25-40 percent indicating the much higher proportion of hydromorphic movement than was observed in profile 1, and consequently greater likelihood of transported origin. Profile 4, is located at the break in slope away from the influence of mineralization. This profile is the most strongly anomalous throughout its depth. From this it can be seen that if the contour map of a regular soil grid was provided, then treating all samples equally the boggy ground 600 feet downslope from mineralization would provide the area of highest geochemical response. If this region was chosen as a geophysical or drilling target, mineralization would not be encountered. The percentage of cold extractable metal is between 45-60% throughout the profile providing a very valuable indication that the metal has been moved by hydromorphic dispersion and in all probability the source does not directly underlie that particular profile. The background bog profile, like the other background profiles, is not anomalous throughout its depth but shows a quite variable degree of cold extractable copper from 10 to 35%.

These data demonstrate that profile sampling, even to the realitively shallow depth of 18 inches, can be very valuable in interpreting the location of the related source, either upslope or directly underneath. Because in most soil anomalies directly overlying mineralization the metal is less readily cold extractable than anomalous metal downslope, it is essential to use a total attack initially during analysis of a soil grid. The cold extractable or other weak attacks are only used where further information regarding the nature of the anomaly is required. In this case however, by using and correctly interpreting weak extractions, information as to whether the anomaly is mechanical or hydromorphic in origin can be obtained.

FIG. 7 VARIATION OF COPPER IN SOIL PROFILES OVER THE CARIBOO-BELL DEPOSIT, McLEASE AREA, B.C.



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mineralization are all third order anomalous, as are virtually all the results over the south and eastern two thirds of the area. The cold 0.5N HCl extractable copper gives little apparent reflection of geology. Using this extraction five of the eight tributaries draining known mineralization are second or first order anomalous, and in addition, anomalous values are found near the headwaters of Creek B, and two tributaries draining from the western side of Creek A. The contrast between threshold and the most strongly anomalous samples is the 4.7. The EDTA extractable copper shows virtually no apparent association with geology as the downstream portion of Creek A has the same range of metal concentration as the area to the northwest. In this case however, seven of the eight tributaries draining from areas of known mineralization are second or first order anomalcus with a maximum contrast of 5.0. In addition, the EDTA extractable copper also shows as anomalous the headwaters of creeks B & C and two tributaries draining from the western side of Creek A.

In conclusion, therefore, the principal point to notice is that the different extracts give different patterns and therefore the interpretation of each will lead to different conclusions. Limited knowledge of "ground truth" in the area makes exact interpretation difficult but several points are apparent. The total metal content reflects geology and at best onlv imperfectly the presence of the best known mineralization. EDTA extractable copper reflects the known mineralization very well, and also accentuates two other anomalies in the area, but does not give any indication as to rock type changes. Cold 0.5N HCl copper gives a picture intermediate between total and EDTA extractable copper. A further indication of the fundamental difference between the three attacks can be seen by com-

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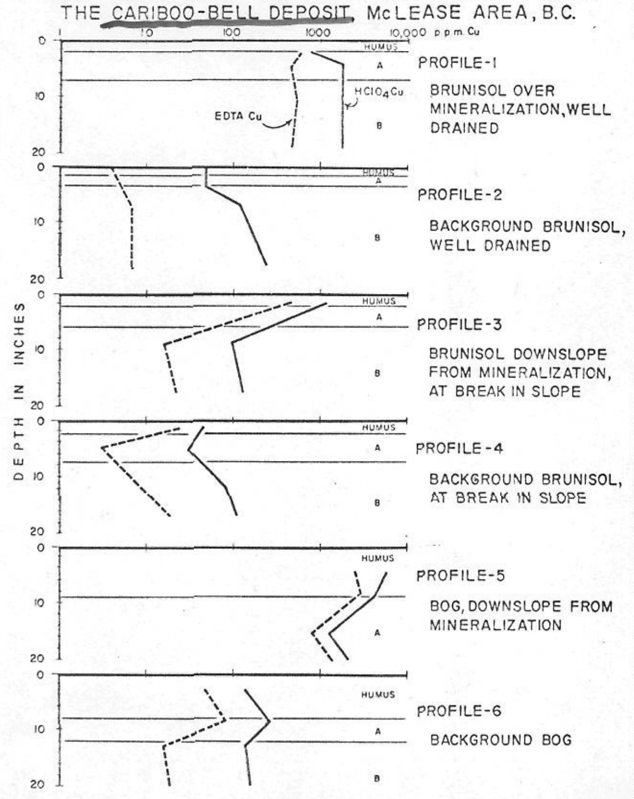

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paring the histograms in Figure 6. The $HClO_4$ extractable copper shows a polymodal distribution indicating that it is reflecting more than one parameter. By definition each parameter has a proportion of its population as anomalous. Consequently the task of having the anomalous values related only to mineralization is difficult. EDTA extractable copper on the other hand has a far more nearly modal distribution. For a modal distribution it is possible to choose an unambiguous threshold and anomalous samples may be more confidently related to mineralization. To determine that the anomalies are related to mineralization and not some other undesirable parameter requires careful orientation.

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6. CONTINENTALLY GLACIATED AREAS

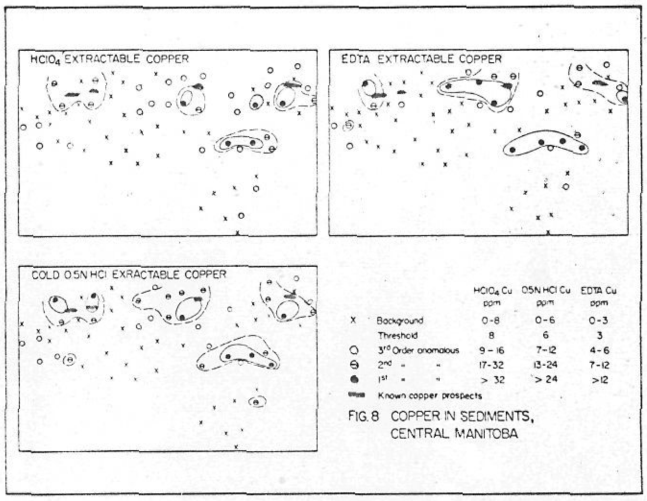

FIG. 8 COPPER IN SEDIMENTS, CENTRAL MANITOBA

The results of three different chemical extractions for copper on stream sediments collected in Central Manitoba are shown in Figure 8. The area is virtually completely drift covered and no reliable geological map of the area is available. The region to the north of the copper prospects is largely underlain by Precambrian metasediments (sandstone, siltstone and some limey sediments) and the area to the south by precambrian granites gneiss. The known copper prospects shown in the figure are massive pyrite/chalcopyrite and as presently known, too small to be of any economic interest. They are apparently related to a major east-west shear zone and there is evidence of parallel shear

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and are even less readily contoured. The variability of anomalies in soil is dependent on variations in the thickness of the till, and the relative movement of different ages of glaication: two factors which are generally far less important in Alpine glaciated areas. If root systems can penetrate into the till, then anomalous metal can rise into the plant and through the normal process of plant decay will also occur in the soil, even though the till may be covered with material of completely foreign provenance such as fluvial outwash or lacustrine sediments. Anomalies will also build up in stream sediments by the mechanism of hydromorphic movement already described for residual soil tropical areas. However, anomalies in stream sediments in continentally glaciated areas are generallv weaker and more erratic than under comparable situations in residual soils largely due to dilution by easily eroded barren till or fluvial and lacustrine clays. In varved clay environments groundwater circulation to the surface may be lost completely. In this case no geochemical surface expression will be obtained.

3. CHEMICAL EXTRACTIONS

3.1 "Total Metal" — Perchloric Acid ($HClO_4$) Extraction

Strictly speaking a hyrdofluoric-perchloric acid extraction evaporated slowly to dryness and taken back up in acid, is probably the only true total wet chemical attack. However this total attack requires a long time and consequently is more expensive than less rigorous chemical attacks, which for all practical purposes give data of equal value to exploration geochemistry. One common such attack is perchloric acid without hydrofluoric acid, kept at the reflux temperature for four hours and allowed to cool and then the metal analysed directly. (When related to exploration geochemistry, this is commonly called a total attack.) This attack extracts all looselv bonded or absorbed metal and metal from alkali silicates such as feldspar, layered silicate such as mica, and sulphides. How some of the iron manganese silicates such as pyroxenes amphiboles and sphene have only 20% to 80% of its metal extracted. This extraction therefore removes between 80% to 100% of the total metal from a soil, sediment, or rock sample. For all practical purposes this provides a geochemical total analysis sufficient to interpret contrasting geological units, and will extract all metal in the sulphide form or its weathered products.

3.2 "Weak Acid" Hydrochloric Acid (HCl) Extraction

Weak acid extractions encompass a large number of attacks of quite variable nature and the specific attack to be used should be chosen by orientation. A weak acid attack will remove loosely bonded and absorbed metal, precipitated salts and possibly attack some of the less resistant silicates such as layered silicates.

In some areas (notably residual and tropical environments) an organic acid (e.g. EDTA) is quite sufficient to remove this type of metal. In other areas however, this attack is not sufficiently strong as due to some natural process, the absorbed metal, although having moved in solution, is bonded more strongly and needs a more vigorous attack to remove it. From experience, hot 0.5N HCl extraction proves quite effective, but the successful use of the hot weak acid extraction is by no means confined to this strength and type of acid alone.

3.3 "Cold Extractable" (EDTA) Extraction

As for the hot weak hydrochloric acid this extraction is intended to remove all loosely bonded material absorbed only on clay particles or rather large surface areas, and metal precipatated as its salt. EDTA is a weak organic acid and has proved very effective for this purpose. From experience, this extraction has been found by earlv workers in geochemistry to be effective in detecting hydromorphically moved material, particularly in tropical environments and has been used, with variation, for some considerable time. Other even weaker extractions, such as sodium citrate buffer, have also been used with varying success in different environments.

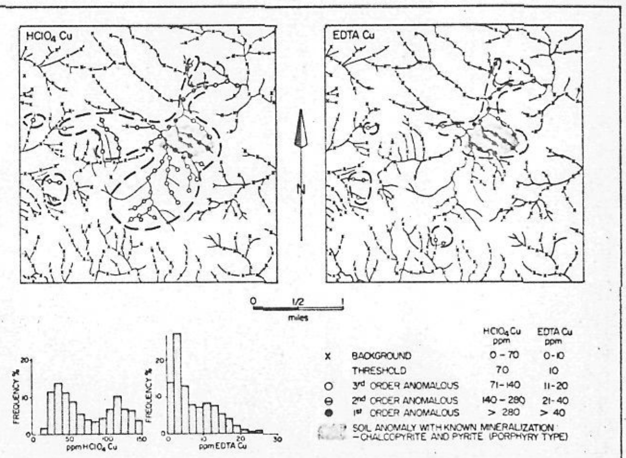

FIG. 4 COPPER IN STREAM SEDIMENTS, FIJI

4. RESIDUAL SOIL, TROPICAL ENVIRONMENT

Figure 4 shows $HClO_4$ and EDTA extractable copper in stream sediment samples collected during a mineral exploration programme in Fiji. Both analytical methods outline the area of anomalous soils with known mineralization, but the patterns observed are somewhat different. This figure also gives the histograms of the metal concentration for background and weakly anomalous values, (definitely anomalous values have been omitted in order to conserve space). In the case of the total extraction, the histogram shows two very distinct and well separated populations. It is evident from the accompanying map that this break at approximately 70 pmp is probably geologically significant and is a reflection of rock type as the values from the two populations plot in discrete areas, rather than spread randomly and intermixed throughout the map. It is particularly apparent that the third order anomalous values upstream from known mineralization cannot have been affected by dispersion from the area of the soil anomaly. Consequently the total analysis for copper is providing not only an anomaly related to mineralization, (with a contrast of threshold to most strongly anomalous sample of 12) but also basic geological information. The cold extractable EDTA results on the other hand show only a very weak separation between the two populations. When this weak division,

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