THE REGIONAL GEOCHEMICAL LANDSCAPE OF THE MORESNET METALLOGENIC DISTRICT

S. DIJKSTRA[1])

A regional streamsediment survey is being carried out by the Mining Exploration Department of ITC in the N.E. Ardennes (Belgium). Up to the present an initial area of some 1200 km^2 has been subjected to a preliminary survey and 600 samples taken from carefully selected sampling sites have been analyzed for hot extractable lead and zinc. The initial object was to investigate the applicability of various techniques of data analysis under the prevailing conditions. Limiting ourselves to the results of the hxZn [2]) analysis, the provisional results are summarized as follows:

Raw data maps already suggest that geographical variations in the hxZn values of stream sediments are controlled by incidental factors of local significance as well as by regional factors. On the whole, however, the maps fail to yield a comprehensive impression and are not suitable for direct interpretation.

Simple procedures for drawing geochemical maps according to conventional methods of contouring individual data proved to be problematic and subjective. A modified procedure, using unequal contour intervals with limits determined by selected critical points in cumulative frequency diagrams, turned out to be more satisfactory and led to the production of a realistic image of the geochemical landscape, containing close to the maximum of detail that could be expected from the given sampling density. This landscape is dominated by an E-W trending zone of high hxZn values and two major discontinuities, corresponding with known geological unconformities. The presence of a series of parallel NNW trending zones is indicated, and map sections with highly irregular patterns can be matched with sections of complex geology. The area peripheral to the city of Liege and the Moresnet metallogenic district coincide with areas of high geochemical relief. High values associated with river systems draining old mining sites were not incorporated in subsequent data analysis.

Trend surface analysis was employed in an attempt to outline the observed trends more clearly.

Inspired by a technique described by Geoffroy, Wu, and Heins in Ec. Geol. 1968, p. 787, a simple averaging method was used to prepare a regional trend map representing the regional components of the geochemical landscape, as well as an areal trend map, representing the combined regional and areal components. Each map was used in turn for drawing a residual map of the areal components.

This technique proved to be capable of separating various trends into regional and areal ones, and the maps produced contributed to a better understanding of the different components of the geochemical landscape. Outlines of the already reported series of NNW trending zones are well defined by the residual map, which map also reveals a few hitherto undetected E-W trends of admittedly limited extention.

Similar results were obtained from trend surfaces and their corresponding residual maps based on electronic computations involving piecewise polynomial functions. For a description of the special technique employed, reference is made to the paper on automatic data processing by Bosman, Eckhart and Kubik, also to be presented during this symposium.

In both instances residual maps of individual

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[1]) ITC and University of Technology Delft.

[2]) hxZn refers to hot HCI extractable Zn.

values indicate a number of additional trends of local significance only. Their existence is to be confirmed by closer sampling patterns.

The relationship between density distributions of various selected factors and regional trace metal variation was investigated in order to facilitate the interpretation of regional trend components. For this purpose, the region was divided into 6 × 6 km cells and center-cell values were determined as function values of the regional trend surface; quantitative factor densities were estimated for each cell as, for example, the percentage of cell covered by swamps, the cumulative length of roads in km, the percentage of cell covered by Namurian formations, etc.

Separate correlation matrices and multiple linear regression equations were computed by ITC's Mathematics Department, both for factors of an essentially litho-stratigraphical nature and factors related to vegetation and contamination. Center-cell values proved to be positively correlated to the density distribution of factors such as Namurian shales, contacts of Namurian shales and Visean limestones, meadows, roads, and proximity to the city of Liege, and negatively correlated to the density distribution of Revinian formations, swamps, and forests. A low order probability correlation was indicated for center-cell values and NNW trending fault zones.

The map showing hxZn residuals of simulated values predicted by the regression equation for non-geological factors and the function values of the regional trend surface indicates, that the main trends, which were observed cannot simply be attributed to vegetation and contamination; an exception is to be made for the concentric zone of high hxZn values near Liege. The residual map associated with essentially litho-stratigraphical factor accounts, in part, for the regional E-W trending zone. Both maps fail to explain the presence of the NNW trending geochemical alignments and, accordingly, they must be considered to be superimposed features having some possible relationship to NNW trending fault systems.

The overall results derived from graphical data presentation and subsequent data analyses suggest that NNW trending geochemical zones and their intersections with E-W trending ones are the main geochemical controls for ore deposits in the Moresnet section of the Namur-Aix la Chapelle metallogenic belt. These results are not inconsistent with geological observations to the effect that most ore deposits in the district occur at oblique intersections of post hercynian NNW trending faults and contacts between Visean limestones and Namurian shales and quartzites. It is postulated, however, that the NNW trending zones of high geochemical relief represent zones of weakness in rock materials that have acted as channelways for solutions associated with ore deposition. Such zones do not necessarily coincide with fault zones that have caused lateral displacement sufficiently extensive to be shown on the geological maps.

In contrast with the NNW trending geochemical zones, which are superimposed on the general strike of various geological formations, the regional E-W trending zone is related in space to the Visean-Namurian contact and the outcrop of the Palaezoic-Mesozoic abrasion plane; in a sense this E-W zone could be described as "stratabound".

Summarizing, it may be concluded that the results of trend surface analysis contributed to a better definition of different components of the geochemical landscape, whilst correlation studies facilitated their interpretation. From the point of view of exploration, it would appear that surveys of this kind, combined with geological studies, may well contribute to the search for environments favorable for ore deposition.

Discussion

G. Friedrich asked if the NNW trending geochemical zones might not have been artificially produced by ancient mining activities.

S. Dijkstra replied that great care had been taken in the selection of sampling points and no samples had been collected from streams draining old mining sites. Moreover, the NNW trending zones continue well outside the different mining districts.

G. Friedrich wondered if the geochemical survey had not simply confirmed the association between NNW trending fault systems and mineralisation, i.e., something that was already known.

S. Dijkstra pointed out that NNW trending fault zones and NNW trending geochemical zones are not entirely indentical. Faultzones which are not accompanied by geochemical zones appear to be barren; furthermore, geochemical zones do not coincide with mapped faultzones in all instances.

H. Martin wondered which part of the total metal content had been extracted during sample decomposition.

S. Dijkstra replied that according to his calculations virtually all sorbed trace metal ions were extracted, together with most trace metal ions contained in readily soluble Pb and Zn minerals and a minor, probably insignificant fraction of the trace metal ions held in structural positions in silicate minerals.

T.A.P. Kwak wanted to know when to use a 3^{rd} order and when to use a 5^{th} order polynomial function in describing trend surfaces.

S. Dijkstra answered that a relatively simple 3^{rd} order polynomial may be used in describing a broad regional trend whereas a 5^{th} order polynomial may be required in order to express more detailed features of a geochemical landscape. With regard to the fundamental issue, whether or not polynomial functions should be used at all in geochemical data analysis, he referred to D. Eckhardt's paper on Automatic Data Processing.

I. de Magnée was keenly interested in the author's remarks on relatively high trace metal values in cretaceous clays, overlying the carboniferous erosion surface. He wondered if these high values would indicate the presence of mineralisation nearby.

S. Dijkstra agreed that the high values at the base of the Cretaceous are intriguing, both from the point of view of exploration and from the point of view of ore genesis. Indications are that the explanation of these high values is a very complex matter; in this context the author thinks in multiple terms such as special local environmental conditions during clay deposition, (palaeo-)supergene processes, and primary and/or secondary dispersion, associated with ore deposition. Absolute proof with regard to any of the above relationships is not available and further investigations are needed.