The Problem of Ore Mobilization in Some Deposits of the Alps and Dinarides

Introduction and Summary

This small Meeting is dedicated to a special subject of IGCP project 169 "Geotectonic Evolution and Metallogenesis in the Eastern Mediterranean": the subject is remobilization of minerals in the alpine-mediterranean ore deposits. This refers directly to the problems concerning the age of the deposits.

Twenty years ago the metallogenesis in the Alps was almost unanimously considered mainly cretaceous-tertiary related to the alpidic orogenesis. This hypothesis was based on the frequent observation of epigenetic ore structures, cross cutting veins and replacements—evidently younger than the alpidic deformation of the adjacent rocks. But careful investigations of stratiform ore structures, carried out by TAUPITZ, SCHNEIDER, SIEGL, SCHULZ and others in the early sixties, have shown sedimentary features. By this way the former unitaristic cretaceous-tertiary metallogenesis became substituted by an almost unistaristic palaeozoic metallogenesis (SCHULZ, TUFAR, HÖLL, MAUCHER and others); this because the majority of the ore deposits in the Eastern Alps is to be found within palaeozoic strata.

In places however where clear epigenetic and non-deformed structures, even within younger strata, are observable, the phenomenon was interpreted as the result of a later remobilization of the ore. In several cases such an explanation was convincing, in other cases it seemed just to be a way out to overcome a contradiction of observations and to save the idea of an old syngenetic mineralization.

The scope of the discussion was to show precise and concrete examples of mobilization, to *determine a possible physico-chemistry* of remobilization, to find out whether remobilized ore has a somewhat different composition than the original ore, to explain why in some cases the wallrock is not effected by the process of ore solution, and finally even, why in several examples palaeozoic syngenetic mineral deposits, although having been exposed to the conditions of alpine metamorphism, are showing no traces of mobilization at all.

For this purpose, not only economic geologists have been invited as speakers, but also chemists and physicists, with the intention of the initiator of the meeting to keep the mobilistic phantasy of some geoscientists within realistic limits.

The result of the lectures and discussions can be summarized as follows:

Anhydrous Carbonates of iron and magnesium precipitate only under elevated CO_2 pressure (GAMSJÄGER)—a condition not known for the Devonian Sea. The mobilization of Fe-Carbonates is being stimulated by increased salinity of the dissolving waters. Ankerite rich in iron is formed at temperatures around 400 °C (ZEMANN). Therefore this epigenetic ankerite occurring at the Erzberg, which locally still reaches into the Permian strata, is either a product of a remobilization derived from the palaeozoic sedimentary iron carbonates, or it results from a special alpidic metallogenesis. The small inhomogenous siderite layers, interbedded in the Devonian limestones, can be explained only as sedimentary (BERAN). *Generally we must expect that carbonate ore minerals of primary and of remobilized origin will differ in their chemical composition* (GAMSJÄGER). In this context, the present author wants' to raise the following question: why several small layers of iron carbonates, particulary of siderite, have preserved their sedimentary fabrics so well, whereas in the same areas a large-scale remobilization has occured?

Studies on remobilization of sulfides are leading to an analogous result. Technological leaching at a temperature of 200 °C and a partial oxygen pressure of 30 kg/cm^2 leads to a rapid transformation of sulphides to sulfates, plus eventually additional hematite. The tetrahedrite of Schwaz is hardly soluble and can be decomposed into its compounds only by successive treatments (WÖBKING). It is therefore particularly remarkable that tetrahedrite (Fahlerz) of Schwaz, which predominantly occurs in Palaeozoic dolomites, has not the same composition as the tetrahedrite appearing in small quantities in the overlying Triassic limestones. The Triassic Fahlerz contains more As, more Cu, however less Sb than the Palaeozoic one (GSTREIN). Theoretically a redeposition of the minerals stibnite, chalcosine and cinabar would be expected after solution of Fahlerz. A comparative study of all Fahlerz occurrences in the Alps would be an interesting topic of research. Recristallization in the syngenetic palaeozoic sulfide-deposits of the Eastern Alps is often recognizable, remobilization however difficult to prove. On the other hand a considerable syndiagenetic mobilization in the Pb-Zn deposits in the Triassic of the type Bleiberg is apparent (SCHULZ - FUCHS). CZERNY comes to the same result, bringing the deposition of the ores into connection with a syndiagenetic dolomitization. The crucial problem of the discordant veins in these deposits is being left open. In Mežica the galena of the veins contains a minor amount of trace elements than the galena of the stratiform ore bodies (DROVENIK).

The Pb-isotopes are giving ambiguous results for determinating the age and the origin of the deposits. Hot NaCl-brines can extract 60—100% of the lead in silicates. Rock-lead can be mixed together with ore lead. The influence of radiogenic lead, derived from the country rock of the deposits, cannot be evaluated precisely. Anyhow the majority of the lead in the alpine deposits shows a higher age than that concluded from geological evidence. This speaks in favour of widespread mobilization processes from deeper laying source rocks (KÖPPEL - SCHROLL).

Small veinlets of sulfides occur in the synsedimentary Cu-U-layers in the Permian of Slovenia, but no mobilization phenomena are observable concerning the uranium minerals (DROVENIK). This is a remarkable difference compared with the uranium mineralization in the Permian sandstones of Mitterberg (Austria).

In the vulcano-sedimentary scheelite deposit of Felbertal near Mittersill, recristallization and local ore mobilization was recognized, whereby the new formed scheelite porphyroblasts are Mo-containing in contrary to the Mo-free veinform scheelite (WESTENBERGER).

A regional remobilization of elements—not of ore deposits—from the Central Dinarides is described by KARAMATA. There neogene acid magmas have transported Cu, Ni, Co and partly also Cr upwards, while migrating through the series of ophiolites. Migration of Cr into silicates is interpreted by AUGUSTITHIS as "Protomobilization". PETRASCHECK and MARINOS already 1954 have described the migration of chromium from ophiolites into adjacent hydrothermal Pb-Zn-carbonate ores in Laurion (Greece). Simliar phenomena could be observed in Bolghar Dagh (Turkey).

The mobilization within the deposits is rather limited. It is chåracteristic that the mobilisates are chemically somewhat different from the original ores.

Much more important than a direct mobilization of deposits seems a widely extended migration of metals in the course of regional magmatic-metamorphic events, by which the migrating metals can be incorporated into preexisting deposits. This the articles by SCHROLL & KÖPPEL and by KARAMATA have demonstrated; it corresponds with former ideas of ANGEL, CLAR, FRIEDRICH. Apparently an older metal stock was more or less put into motion during Cretaceous and Tertiary time due to regional rise of temperature. A correlation of palaeozoic ore zones in the Alps with unproven variscian subduction zones, is an equation with at least two unknown factors.

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