The Problem of the Ore-Mobilization and -Transport in the Lead-Zinc-Ore Deposits of the Ost-Alpine Middle Triassic Beds

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SUMMARY

After twenty years of discussion on the genesis of the so-called Alpine lead-zinc-ores now the major part of our colleagues agree upon the syngenetic (partly syn-sedimentary) origin of the ore matter. However, in the most deposits there are dominating replacement structures (chiefly the mineable ore bodies!) and unconformable ore veins, which we now must interprete as products of remobilization processes. The different stages of transformation and recrystallization are fixed in many figures, from the scale of thin sections up to outcrops.

Graingrowth and replacement fabrics of ores as well as of carbonate host rocks show nearly the same stages, thus proving their interdependency with the diagenetic development. Whereas ore fabrics reveal an evident tendency to a more rapid graingrowth than the carbonate rock. Interpretations of this well known behavior are presented by activity of formation water and specific physico-chemical conditions during the diagenesis.

The most important groups of factors controlling the diagenetic transformation processes and remobilization of ore matter are:

1. Solubility equilibria of primary sulfides.
2. Facies of sedimentary host rock and its paleogeographic patterns.
3. Composition and physico-chemical conditions of pore solutions and their alteration (e. g. salinity, concentration, temperature, pressure).
4. Permeability of host rock, changing with diagenetic stages.
5. Succession and intensity of all processes depending on the geological history (e. g. geosyncline — orogenesis).
6. Spatial trend (direction) of the acting fluids (solution — transport — precipitation).

DISCUSSION

Amstutz: I simply would like to underline for my part, as an outsider, the importance of this very early work and it is certainly nice to look back now and see how important these observations have been. I would again

like to say how happy I was to visit Munich in 1958 and to see my observations in the Mississippi Valley confirmed. After 1958 I had an opportunity for frequent exchange. Now back to the subject: I am not sure whether I would agree with your term "early diagenetic". I suggest in turn to use the terminology of D a p p l e s and of some other sandstone and carbonate specialists who do not consider anything early any more when cementation has started. There are normaly three phases of diagenetic differentiation. What you consider here an early diagenetic remobilization in their terms would be called middle or late diagenetic re-working, because as soon as the cementation has started or is finished, this is already middle to late diagenetic. I am very concerned about this point because I think it is possible to date the sulfide crystallization during diagenesis. Many features, many texture patterns of PbS are only existing the way as we see them because PbS is distinctly late diagenetic. Sphalerite is normally middle diagenetic and pyrite is the so-called "Durchläufer". Much of it is early, but some of it is occasionally also late. And to finish my point, here I think many geometric patterns we see in regard to the galena are due to its ability to migrate during the early and the middle diagenetic periods. And to migrate sometimes with the mud. So I think it is extremely important in the sedimentary sequence to find a rock which has not been recrystallized so many times, in order to date and to observe the patterns there and to date also the sulfides. And then to go beyond and to look at the more recrystallized patterns. That is also the suggestion I make with regard to the metamorphic deposits. I myself don't dare to look at the metamorphic deposits without knowing the normal metamorphic sequence.

Schneider: The problem of calling this early diagenetic or middle diagenetic processes, that's a problem very often discussed amongst all sedimentologists especially those dealing with carbonate rocks. I showed you a slide of the so-called Wetterstein limestone with a special texture. We hawe small parts of two to three cms in diameter (they are stained by alizarine-S red as calcite) and outside you have a white or grey rim. They are formed by an early diagenetic dolomite. And this also has been accepted by Mr. F a l k and Mr. F r i e d m a n, just in Heidelberg we had a discussion about it. I know or we all know in Germany that a great part of sedimentologists, especially American colleagues, don't believe in this. But now they are changing their minds. You see, this rim of dolomite is formed during the resedimentation of the breccia. And this was proved for the early diagenesis. Because, this is only possible, this dolomite forming, at that period by short uplift at the supertidal level. And this is observed also today, recently. In the reefs of the Caribbean Sea and in the Persian Gulf have been observed these recent early diagenetic formings of dolomite. And also M ü l l e r observed this and has published it, from the Teneriffa, I suppose. And if you have in the same part of where you have some brecciated parts of galena or sphalerite, then you must agree with the early diagenetic process.

Amstutz: I won't disagree with this, but what we actually have here is a misunderstanding. I entirely agree with you that you have two

periods of diagenesis, one first formed the zinc layers which then were brecciated, and then followed the second period of diagenesis, this is, you have at the early stage of diagenesis the change around the rim. You have two periods of diagenesis, and one may speak of a rejuvenation of diagenetic crystallization.

Schroll: Die Lagerstätten der ostalpinen Mitteltrias haben ihre thermische Geschichte. Darüber, ob die syngenetische Ausscheidung bei hoher Temperatur erfolgt ist, kann man streiten. Aber die Annahme des zweiten thermischen Ereignisses, das Sie in die Kreide oder in den Jura verlegen, möchte ich durch folgenden Gesichtspunkt unterstützen: Wir können die Existenz des blauen Anhydrites, der eine Spätbildung ist und nach den Isotopenuntersuchungen Meerwassersulfat enthält, nur so erklären, daß es primären salinaren Gyps gegeben hat. Die unregelmäßigen Verdrängungsmassen blauen Anhydrites müssen zu einem späteren Zeitpunkt unabhängig von der Vererzung gebildet worden sein.

Es wird noch folgende Frage gestellt: Sie haben mikroskopische Einschlüsse von Erzmineralen erwähnt, die Sie in Bleiglanz und Zinkblende gefunden haben. Es hätte mich interessiert, ob Sie auch Thalliumminerallien gefunden haben und welche?

Klemm: Tl-Gehalte ließen sich in der Schalenblende lediglich auf diskreten Schalenpartien qualitativ mit der Ionenmikrosonde nachweisen. Ob das Tl an submikroskopische Kristallite im Porenvolumen an das ZnS gebungen vorliegt, ließ sich nicht ermitteln.

Maucher: Vor nunmehr 20 Jahren hat Herr Schneider seine Arbeiten über die Blei-Zink-Lagerstätten in Karbonatgesteinen der alpinen Trias begonnen. Es soll hier betont werden, daß er der erste war, der die synsedimentären Strukturen erkannt hat. Es ist sein Verdienst, die wertvolle Diskussion über die Blei-Zink-Lagerstättten in Karbonatgesteinen (z. T. gemeinsam mit Taupitz) ausgelöst zu haben. Seine Ergebnisse wurden von mir in einer gemeinsamen Arbeit bereits 1956 beim Internationalen geologischen Kongress in Mexiko vorgetragen. Ich möchte hier auf die Priorität von H. J. Schneider und auf seine Verdienste heute, nach 20 Jahren, betont hinweisen.