Remobilization Processes (Chromite-Mobilization)

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With 4 Figures

Introductory Remarks

As one of the last speakers, I want to express my anticipation of the many interesting papers presented at this pioneer meeting of I.G.C.P. project 169 which concerns the "Mobilization of ores in the Alpine-Mediterranean Area".

I feel that it is also my duty, on this occasion, to recall and mention the work of colleagues on the subject of "mobilization" and to mention some past-work of mine which is also connected with this subject.

Particularly, I want to mention the following cases of mobilization or remobilization:

a) The occurrence of palingenic veinlets of cassiterite transversing colloform pitchblende from Grampound Road Mine, St. Stephens, Cornwall, observed by P. RAMDOHR and also studied by AUGUSTITHIS (1964). Such cases are considered to present mobilizations of cassiterite of hypothermal deposition, mobilized and re-deposited in veinlets in the epithermal pitchblende paragenesis.

b) The occurrence of different lead isotopes in syneresis cracks of pitchblende; RAMDOHR (1960) and later AUGUSTITHIS (1964) considering lead mobilizations in syneresis cracks of pitchblende have attributed the lead concentration in the shrinkagecracks as due to mobilization and segregation of the radiogenic interspersed lead, formed as minute granules within the pitchblende and also due to the mobilization of non-radiogenic lead.

The mobilization of different lead isotopes in syneresis cracks of the pitchblende is a process comparable to the "remobilization" of lead isotopes as is put forward in the excellent presentation by Prof. SCHROLL in his paper "Isotopengeochemie des Bleis in Beziehung zur Remobilisation".

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c) Pitchblende mobilizations in sandstone. Still another interesting example of mobilization of uranium, from initial uranium oxides, is provided in the case of colloform pitchblende sphaericules occupying the intergranular pore-spaces of the sandstone of Val Rendena, Trentino, Italy, see AUGUSTITHIS (1964).

d) Mobilization of boron (tourmaline) in granites and pegmatites from the country-rocks. Perhaps one of the pioneering works on mobilization is the contribution of GOLDSCHMIDT and DRESCHER-KADEN (see GOLDSCHMIDT, 1954). In this connection it is interesting to quote the following from the book of GOLDSCHMIDT, "Geochemistry":

"An investigation by the author and his friend Professor F. K. DRESCHER, then at Clausthal, on the boron in shales, hornfelses and granites of the Hartzburg district, showed that the amount of boron decreases from the shales to the hornfelses of the contact zone and that the granite here takes up boron from the sediments, quite a reversal from established views in petrology."

Indeed comparable cases of tourmaline and boron mobilizations are reported also in pegmatites transversing tourmaliniferous gneisses by DRESCHER-KADEN (1969) and AUGUSTITHIS (1973).

e) Gold-boron mobilizations in auriferous quartz-pyrite veins in granodiorites.

Another case of tourmaline mobilization and gold mobilization is reported by AUGUSTITHIS (1967) in the case of gold-tourmaline-pyrite quartz veins transversing the granodiorite of Ondonock region, W. Ethiopian, in which case it is suggested that both the gold and B are mobilized due to lateral segregation from the granodiorite transversed by the auriferous veins.

f) Mobilization of Pt from ultrabasics to build ferroplatin nuggets in the lateritic covers of dunite.

A rather controversial case of P.G.E. and Au mobilization at relatively low temperatures (by leaching) is reported by OTTEMANN and AUGUSTITHIS (1967) in the lateritic covers of the Yubdo ultrabasic complex (W. Ethiopia). The formation of ferroplatin nuggets is attributed to the mobilization of P.G.E. and Au from P.G.M. present in the dunite and due to Au mobilization from veinform quartz-bodies occurring in the area.

g) Gold mobilization and gold-nuggets formation.

MACHAIRAS (1963), GONI et al. (1967) and HISAHIDE HONMA et al. (1976), have experimentally demonstrated the formation of gold-nuggets from colloid solutions. The experimental work suggests that natural nuggets are remobilizations of gold and are due to gold coagulations from low temperature colloid solutions.

However, in despite of an extensive literature of studied cases of mobilization and remobilization, the present meeting is of great significance for it is an "open forum" for discussing mobilization, its geochemistry and mechanism. It is in this "open forum" of discussion that I want to present some cases of chromite mobilization (or rather remobilization).

Chromite Remobilization

In contrast to the well-established cases of mobilization mentioned, the mobilization of chromite is more dubious and uncertain, nevertheless cases are reported where a chromite mobilization is possible, *e. g.* mobilization of chromite with fuchsite and mobilization of chromite into cracks of anorthosite.

A unique case of chromite mobilization is reported by HUTTON (1942) from Dead Horse Creek, Otango, New Zealand, where fuchsite is found in schists. A remarkable feature is that the fuchsite contains small crystals of chromite. HUTTON'S interpretation is that the fuchsite-schists are the result of chrome metasomatism brought about by penetration and soaking of narrow zones of quartz-feldspathic schists by solutions at high temperature of aqueous chromium-bearing vapours. Within these processes is also to be understood the mobilization of chromite.

In addition to the case of mobilization of chromite associated with fuchsite, the phenomenology of chromite remobilization is extensively discussed and shown by AUGUSTITHIS, 1979, 1982.

In contrast to the magmatic hypothesis of layered chromite-dunite bodies, as a result of crystal-fractionation of basaltic magma, the schlieren chromite bands, the chromite-"potato"-bodies and the leopard chromite structures are considered by AUGUSTITHIS (1979) as tectonic mobilizations in the mantle and represent proto-tectonic changes in it.

Perhaps a most impressive case of chromite mobilization or remobilization is the chromite banding with anorthosite at Dwars River, East-Bushveld, Transvaal. AUGUSTITHIS (1982), in contrast to previous views, has presented evidence in support of tectonic mobilization for the Dwars River chromite-anorthosite banding, also see Fig. 1.

As a corollary, Fig. 2 shows chromite bodies in anorthosite bands, the chromite bodies show resorbed boundaries and remobilized extentions filling cracks of the anorthosite, as is particularly indicated by arrow "a" in Fig. 2. Additional studies show a crack in the anorthosite occupied by chromite, see Fig. 3.

Furthermore, detailed microscopic observations, Fig. 4, show a fissure in the anorthosite followed and occupied by chromite. The chromite crystals are not restricted in the crack but extend into the anorthosite as well.

Considering the banded chromite-anorthosite occurrence at Dwars River, it has been shown that wedge and lens-shaped anorthosite bodies occur in chromite bands, a structural relationship incompatible with the fractional crystallization hypothesis, according to which it is difficult to explain wedgeshaped anorthosite, as fractional crystallization in the heavier chromite layers.

An additional feature, again incompatible with the fractional crystallization, is the distribution of the pyroxenes (diopside) within the anorthosite. The pyroxene differs in specific weight in comparison to the plagioclases; it occurs as pointed out in patches within the anorthosite and there is no evidence of crystal layering or cryptic layering with the plagioclases of the anorthosite.

Furthermore, the patchy distribution of the pyroxene in the "banded" (layered) chromite-anorthosite of the Dwars River indicates that the crystal-fractionation mechanism is not responsible for the distribution of the pyroxenes in the anorthosite (something which would have been expected); as well as for the "banded" association chromite-anorthosite.

As pointed out the chromite-anorthosite banding is due to tectonic "mobilization", an explanation supported by detailed field observation in the paper by the author (1982) "Chromite Remobilization".

An additional type of mobilization is reported from Greece by AUGUSTITHIS (1979, 1982), in which case both the schlieren chromite of Xerolivado, and the leopard chromite-ore from Koursumia. Kozani, are interpreted as tectonic mobilizations within the mantle material (dunite), either under mantle obduction ore diapirism of the alpidic type.

Regarding tihe schlieren chromite in addition to the orientation of the long axis of the olivines parallel to the chromite bands, there is also an orientation of the deformation–twin plane of the forsterites with the chromite bands, which supports rather an interpretation of a tectonic mobilization for the schlieren chromite within the dunite (mantle), under prototectonic conditions. Similarly the Koursumia chromite leopard-ore is explained by AUGUSTITHIS (1979, 1982) as chromite boudinage, whereas the typical leopard chromite-ore is regarded as "ellipsoids" of the strain ellipsoid type.

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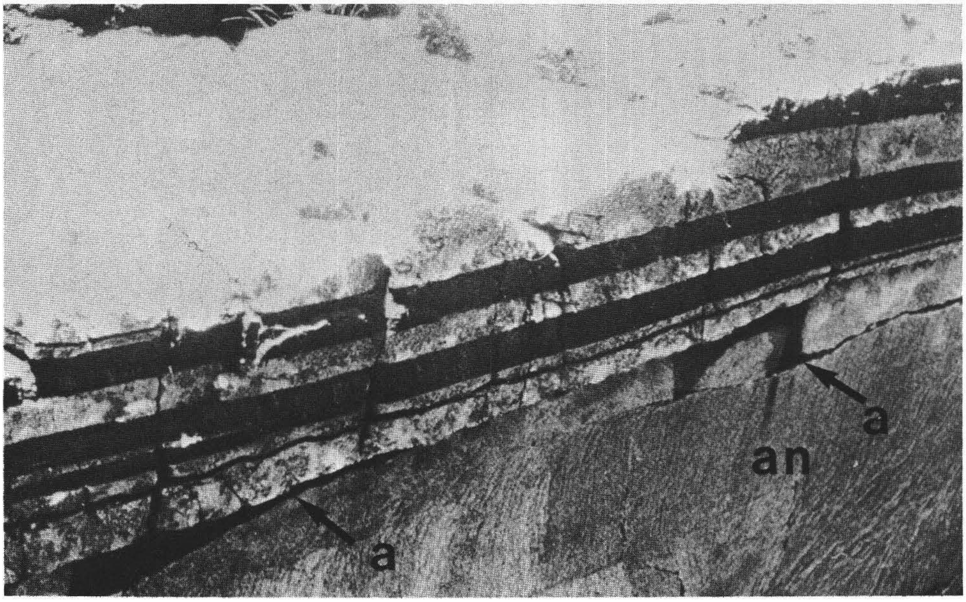

Fig. 1. Chromite-anorthosite banding. Anorthosite free of chromite at the bottom (an). Chromite band exhibiting irregularities tectonically caused (see arrows "a"). Dwars River, Eastern Bushveld, Transvaal, South Africa. The two main chromite bands are about 20 cm each, in thickness.

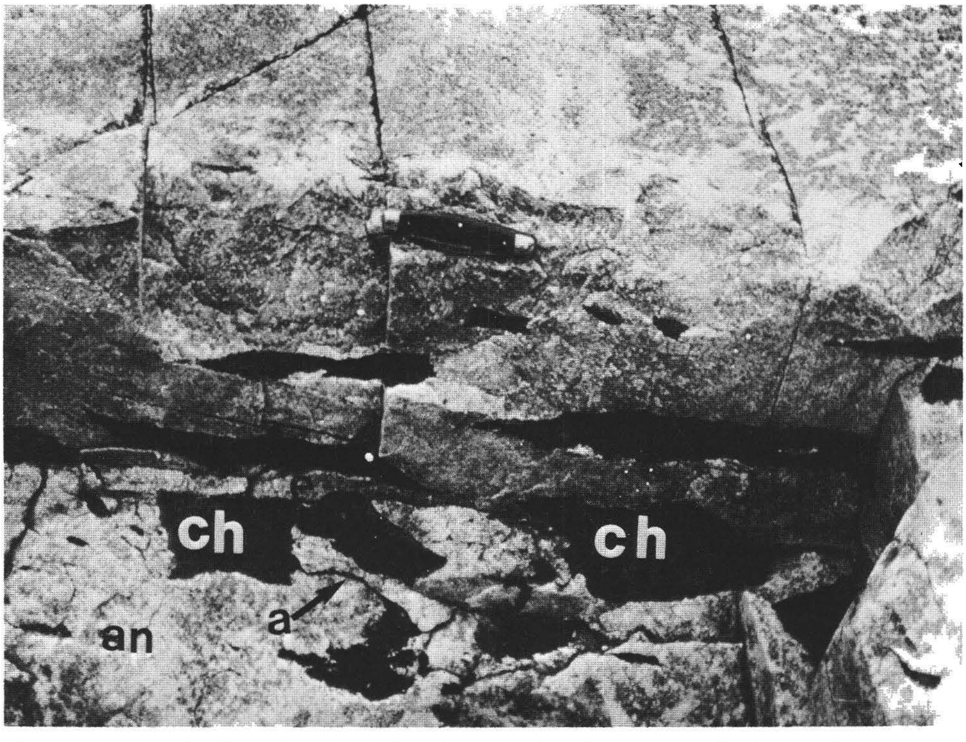

Fig. 2. Chromite bodies (ch) included and resorbed within an anorthosite band. Arrow "a" shows remobilized chromite following cracks in the anorthosite (an). Dwars River, Eastern Bushveld, Transvaal, South Africa.

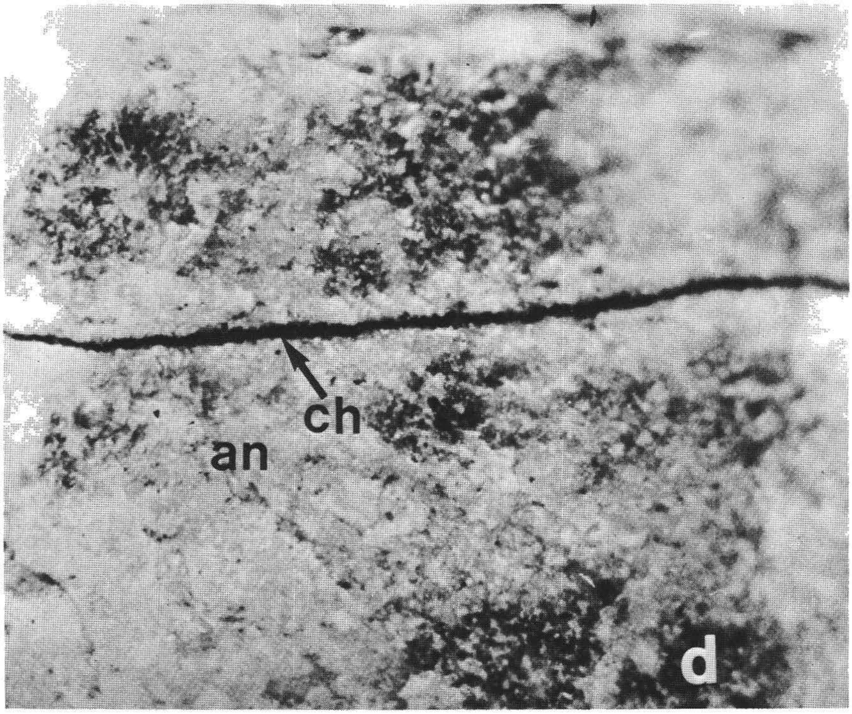

Fig. 3. Fine chromite band (ch) following a crack in the anorthosite (an). Also diopside (d) patches are included in the anorthosite. Dwars River, Eastern Bushveld, Transvaal, South Africa. About natural size.

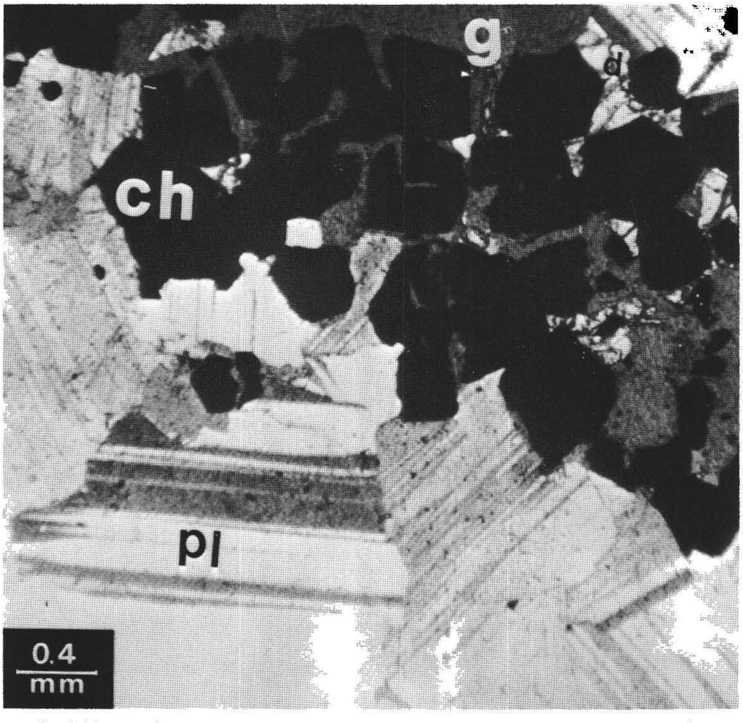

Fig. 4. (Detail of Fig. 3) Chromite crystals following a crack within the anorthosite. ch = chromite, pl = plagioclase, d = diopside, g = glass of the slide. Dwars River, Eastern Bushveld, Transvaal, South Africa. With crossed nicols.