alteration of accessory minerals in the source rocks which results from the interaction with a fluid phase, depends on: 1) the nature of the accessory mineral, and especially the solubility of the mineral (Sd) under the dissolution conditions; 2) the solubility (Sf) of this mineral in the fluid which depends on the initial concentration of the elements such as U, Th, REE, P and ligand concentration in the fluid; 3) the water-rock ratio and the flow regime in the granite; 4) the excange and interactions surface between fluid and minerals, which depends on the degree of microfaulting, and amount of microcraks in minerals. It is clear that fractionation results, not only from the element trasport and ore crystallization, but also from differential leaching of accessory minerals in the source rocks. According to the relative stability of the accessory minerals in the percolating fluid, LREE or HREE enrichements may result respectively from monazite, allanite (or fluocerite, parisite,...) or xenotime, yttroparisite, instability.

As a summary, the following parameters have to be taken into consideration for the understanding of the U, The, REE leaching, trasnport and deposition:

1) nature, abundance, and alterability of U, Th, REE-bearing phases in the source rocks;
relative content of U-Th-REE among their different bearing (accessory or not) minerals;
2) composition of the fluid phase (concentration levels of trace elements, ligands, (especially F^-, CO_3^{2-} and PO_4^{3-},...);
3) P-T-X conditions in the precipitation zone, and nature of the precipitated minerals;
4) behaviour of the ore minerals during post-crystallization processes (alteration, radioactive demage, weathering,...).

Such consideration may help greatly the interpretation of the ore geochemical features. Also, the study of the mineralogical form of U, Th and REE wuold ensure a correct interpretation of the whole rock geochemistry either in the source rocks or in the host rock of the mineralization, Then, it appears necessary to distinguish wether the mineralogical and geochemical features of these rocks were acquired at the magmatic, hydrothermal, or supergene stage.

REFERENCES

CATHELINEAU M. (1987) - *U-Th-REE mobility during albitization and quartz dissolution in granitoïds: evidence from South East French Massif Central.* Bull. Mineral., vol. 110, 249-259.

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CATHELINEAU M.*, DUBESSY J.*, MARIGNAC C.**, POTY B.*, WEISBROD A.** - *Fluids in granitic environments*

The very general fact of spatial relations between granitoid intrusions and various kinds of ore mineralizations have from long focused interest into fluid behaviour in such magmatic bodies. Recently developed tools such as fluid inclusions or stable isotopes studies have provided a wealth of new data which give a better insight into the fluid production and circulation associated whith the emplacement of granitic plutons and their cooling and further evolution.

Three successive generations of fluids will be distinguished:

I. Magmatic fluids - Crystallization of anhydrous minerals from the magma produces a water increase and leads to the formation of a fluids phase co-existing with the melt and crystal («resurgent boiling» BURNHAM, 1979; BURNHAM and OHMOTO, 1980). Few direct initial witnesses of this stage are presently observed, because of the frequent recrystallization of the melt inclusions (NAUMOV et al. 1977). Inclusions exhibit silicate crystal with a fluid phase, and sometimes three phases (at high temperature): two immiscible melts, a silicate and a saline one plus a fluid phase (REYF and BAZHEYEF, 1977).

II.a. - At the end of crystallization, at last, magmatic fluids are exsolved and may be studied for themselves. Unfortunately, there is a poor record of such fluids, either because of a lack of trapping or because they were not sought for (or were not recognized). Nevertheless, there are at least three situations where the expression of late magmatic fluids was clearly observed:

— in boron enriched granitic systems, unmixing of a B-rich aqueous brine (up to 60% eq. NaCl) is locally observed, and is reflected by the crystallization of «quartz - tourmaline» or «flour» rocks frequently occurring as braccia pipes (Cornwall, Bolivia, for instance) (CHAROY, 1979; GRANT et al., 1980);
— in porphyry copper intrusives, where these fluids are complex brines, characterized by their high temperature (600°C and more) and high K/Na ratio (ROEDDER, 1971, EASTOE, 1978, DENIS et al., 1980; RAMBOZ, 1979);
— in sodalithic granites, such as the Beauvoir granite at Echassières; these late magmatic fluids appear enriched in Li and F, and are also characterized by their high temperature (close to the lowered eutectic of ≈ 560-580°C of the F-Li-enriched magma) and high K/Na ratio (AISSA, 1978).

In these two late examples, boiling of exsolved brines (so called secondary boiling) is a common feature. In every case, the early circulations of these late magmatic fluids mark the beginning of rather long-lived hydrothermal circulations involving fluids of non-magmatic origin.

II.b. Even in the absence of evidence of late magmatic fluids, early interactions of aqueous-dominated fluids coming from the surrounding of the intrusions is often recorded and sometimes spectacularly; such is the case for:

— the greizenisation process, involving «meteoric» waters (JACKSON et al., 1982) at high temperature (up to 500-550°C) (CHAROY, 1979);
— the reducing effect to CO_2-CH_4 aqueous fluids evolved from graphite-rich gneissic levels into the alaskitic magma of Rössing, yielding the massive crystallization of uraninite (CUNEY, 1980).

Fluids evolved from devolitization of C-rich (meta)sediments are a rather frequent compound of high temperature fluid circulations in granites, as exemplified by those observed in the intragranitic contact zones in the Southern part of the French Massif Central (Bondons, Mt. Lozère) which are similar to those observed in Sn-W veins (RAMBOZ at al., 1985; WEISBROD, 1986; DUBESSY et al., 1987). These fluids have rather low fO_2, controlled by equilibrium in the C-O-H-N system (± graphite).

III. After cooling, most granites are again submitted to fluid circulations induced either by their own peculiarites (HHP granites, FEHN and CATHLES; 1978 for instance) or by subsequent thermal disturbance (late magmatic intrusions, for instance). Fluids developed local to relatively pervasive subsolidus alterations. Quartz dissolution together with K or Na metasomatism, pervasive chloritization, and structured crystallization of phyllosilicates (phengites) are the main observed processes. In most cases, fluids are meteoric, have aqueous compositions and low salinities, and temperatures range from 250 to 400°C. pH controls largely at this stage the nature of the mineralogical assemblages.

Low temperaure (80-120°C) alteration of granites give diffuse and extended alteration of feldspars and phyllosilicate into smectites (CATHELINEAU, 1987). The chemical modelling shows that smectitization is genetically distinct of kaolinization. Kaolinite crystallizes in higly microfaulted and early altered zones, and forms either in hydrothermal or supergene conditions.

Concluding remark:

1) careful studies of selected examples of numerous kinds of granite — related mineralization clearly demonstrate that ore deposition may occur at any stage of the long — lived evolution of fluid circulations which have just been presented. Thus, it appears that the orthomagmatic models of ore generation are too simple and cannot explain the observed occurrences;
2) most observed trapped fluids appear to be of late generation more or less associated with rather low temperature fluid circulations (< 400°C) and earlier stages have often been more or less overprinted, and may be difficult to recognize. As a consequence, there is also a general overprint of low temperature assemblages, generally weak, but sometimes quantitatively significant. The significance, of such processes for the recognition of magmatic features, especially the trace elements distributions should not be ignored.

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CHERCHI G.P.*, ELTER F.M.*, GHEZZO C.*, MARCELLO A.**, MUSUMECI G.*** - *Intrusive sequence and structural pattern of the granitical Hercynian complex from the Calangianus region (Northern Sardinia)*

The Hercynian Sardinia - Corsica Batholith in the Calangianus region is composed by two granitic suites:

— Several monzogranitic plutons and stocks belonging to a late-tectonic sequence. They are constituted by pinkish coarse-grained biotite monzogranite characterized by K-feldspar megacryst and microgranular mafic magmatic xenoliths. A planar magmatic flow structure is usually recognizable at a mesoscopic scale.

— Several leucogranitic plutons, stocks and dykes belonging to a post-tectonic intrusive event. They are constituted by coarse and fine-grained biotite leucogranites.

All these plutonic bodies are extensively affcted by tectonic fracture systems (mainly with N 10°-50°, N 80°-90°, N. 110°-150° trending directions).

From field observations on pluton shape and contacts, their planar fabric and fracture systems, it follows that:

— Within the monzogranitic intrusions a sequence of emplacement at relatively shallow levels towards more leucocratic types is pointed out; the planar fabric shows variable trajectories which a main N 70° trend and clearly defines a multiple intrusion pattern.

— The post-tectonic shallow level younger leucogranitic intrusions were emplaced mainly along NE-SW directions.

— The fracture pattern is due to a complex superposition of joints of variable nature and age (from late-Hercynian to Alpine).

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WORK SUPPORTED BY E.M.S.A. AND C.N.R. GRANTS.

COCIRTA C.*, MICHON G.* - *Mafic microgranular enclaves of Northern Sardinia granitoids: the existence of two different acid-basic associations*

The carboniferous calc-alcalics granitoids (280-230 M.a.) of the northern Sardinia are regrouped in three units: G1) tonalogranodiorites rich in decimetrical microgranular basic enclaves (E1); G2) monzogranites poorer in enclaves (E2); G3) leucogranites with very few enclaves (E3). Usually these enclaves have a various and heterogenous chemistry, where contamination phenomenons are obvious for some of them. The little (or none) contaminated enclaves are divided into two populations (Fig. 1): the one (E1) characterised by a FeO enrichment and a MgO impoverishment, and the other one, (E2 and E3) by a FeO, MgO, CaO impoverishment. The evolution of little (or non) contaminated enclaves are comparable to those of Punta Falcone composite basic stock (Northern Sardinia) where one observes (Fig. 1) a leucogabbroic trend with a calc-alcalic tendency, and a gabbroic trend which is characterised by an FeO enrichment; mingling and hybridation phenomenons are present at the periphery of this massif.

The magmas that produced the eclaves E1 (included in the infracrustal granitoids G1) are close to initial stages of a the presupposed tholeiitic trend of a basic liquid. The magmas that produced the enclaves E2 and E3