Pb-Pb dating of uranium ore deposits: ion probe measurements of fracture fillings in the Palmottu granite (Southern Finland)

C. Pomiès
B. Hamelin
CEREGE, Europôle méditerranée de l'Arbois, UMR 6635 BP 80, 13545 Aix en Provence cedex 4, France

J. Lancelot
Géophysique-Géochimie-Pétrologie, UMR 5567, Université Montpellier 2, CC 066, 34095 Montpellier cedex 5 France

J. Casanova
BRGM, Av C. Guillemin, BP 6009, 45060 Orléans cedex 2 France

The Palmottu U/Th deposit is located in the southeastern part of the Baltic shield (SW Finland). The mineralisation bedrock belongs to the Svecofennian domain of the Svecokarelian orogeny. This orogeny, which occurred about 1.9–1.8 Ga ago, involved folding and general metamorphism of Jatulian sediments (2.2–2.0 Ga), and synorogenic plutonism. Intrusions of post-orogenic plutons occurred during the final stages (1.8 Ga). The U/Th ore consists mainly of disseminated uraninite, related to this latest stage (Räisänen 1986). Pb isotope and U repartition have been analysed in calcium carbonate veins of probable hydrothermal origin, within fractures related to the ore body. This study is part of an EEC research program on nuclear waste disposal in cristalline bedrocks.

Sampling and analytical techniques

Four drill-cores were sampled along an east-west profile across the ore. Each drill hole is roughly perpendicular to the mineralisation plane. Fractures filled with calcite with low amount of clay minerals were selected in gneiss and pegmatitic granite.

These fractures are generally very thin (0.2–5 mm).

The fracture fillings were removed mechanically from the bedrock. The amount of sample is generally less than 100 mg. SEM analyses of these samples reveal a complex mineralogy, consisting of calcite with pyrite inclusions at various state of alteration, associated with diffuse uranium silicates (coffinite). The mineral inclusions of pyrite are too small

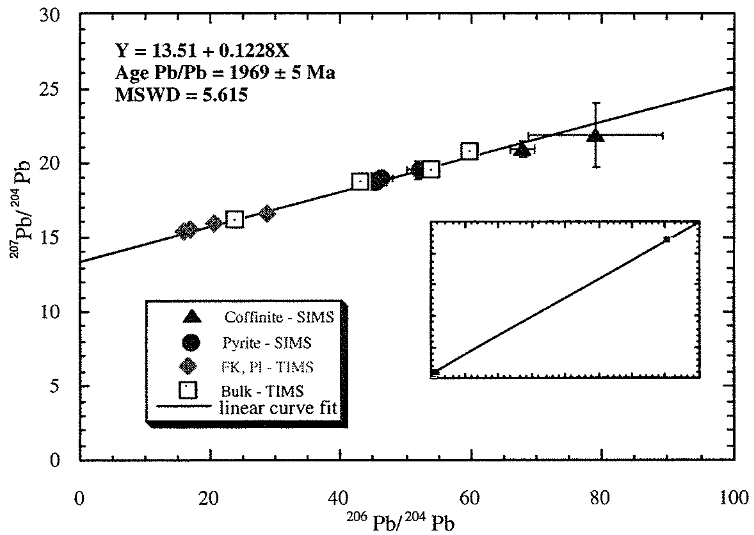

FIG. 1. Lead isotopic compositions of fracture fillings (F. fillings) and mineral inclusions (pyrite, coffinite). The isotopic composition of surrounding granite (Pl:Plagioclases, FK: K. Feldspars) have been also plotted.

(<40μm) to be properly separated.

SIMS analyses of pyrites, coffinites and monazite were performed on a CAMECA IMS 4f ion probe at the GGP laboratory in Montpellier. A positive oxygen primary ion beam of 20 nA, and a mass resolution of 1500, were used for these analyses. The external reproducibility (0.37%, n = 11) and instrumental mass fractionnation (0.372% per amu) were monitored by repeated measurements of the Aloui Galena.

TIMS measurements in bulk vein samples have been obtained on a Finnigan MAT 262 (TIMS) at CEREGE (Aix-en-Provence).

Result and discussion

Lead isotopic data obtained by TIMS and SIMS are shown in the $^{207}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ diagram in Fig. 1. Very radiogenic $^{206}Pb/^{204}Pb$ ratios have been obtained both in bulk samples and in pyrites ($20 < {}^{206}Pb/^{204}Pb < 3500$). These results are clearly related to the very high uranium concentrations measured in these samples (100–2000 ppm). TIMS and SIMS data plot along the same line. The common-lead composition of the surrounding granites, given by TIMS analyses of plagioclases and K-feldspars also plot on the same line. The slope of this array gives a Pb/Pb age of 1969 ± 5 Ma (MSWD = 5.6, n = 12). This can be considered as a good approximation of the age of uranium ore formation, assuming that the veins crystallised at the same time as the ore deposit itself.

The U/Pb system seems to have remained closed since the crystallisation of the veins. However, recent fractionnation between lead and uranium (younger than *c.* 30 Ma) could have occurred without affecting the Pb/Pb isotopic system. In order to check for possible recent U mobility, the U/Pb systematics is presently under investigations in these samples, both by TIMS and SIMS. $^{230}Th/^{238}U$ disequilibrium data will also be shown at the meeting.

References

Räisänen, E. (1986) Report IAEA-TC-571, 12p.