Kontinentales Tiefbohrprogramm der Bundesrepublik Deutschland

Isotope Geochemistry, Oberpfalz

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Between 1/3 - 2/3 of the earth's heat flow is produced by the radioactive decay of uranium, thorium and potassium in the crust.

The temperature-profile depends on the amount and distribution of U, Th and K in the crust, the basal heat transfer from the upper mantle, and the heat conductivity of the rocks. In the weathering zone, often several 100 meters deep, uranium is highly mobile. If it is unknown to what extent uranium-migration has taken place, errors in the prediction of the temperature-depth-distribution are possible due to the thermal inertia of the rocks.

Isotope-geochemistry is the only practicable way to control the mobility of uranium. There are two ways to detect uranium transport: Concordia-diagrams are useful to determine time and volume of uranium-migration if the uranogenic in situ growth of lead is great enough, like in the Granite Mountains in Wyoming (ca. 2 Ga).

For the much younger granitic rocks of the Oberpfalz a second way to determine the direction and extent (but not time) of uranium-transfer is applied. The measurable μ-value ($^{238}U/^{204}Pb$) of the whole rock and a postulated μ-value indicated by the Pb-isotopes of the whole rock and feldspar (Pb-initial) should agree if the U/Pb-system was closed since the time of rock-forming. If not, direction and volume of the uranium-migration is recognizable.
Furthermore, Pb/Pb-isochrons of whole rock and minerals can be useful to prove the state of a U/Pb-system.

First results

Significant results for the Falkenberg granite are presented here concerning WR and feldspars of 7 samples and Bi and Ms of one sample (fig.1). These data are clear evidence for a closed U/Pb-system in the Falkenberg granite. Pb/Pb-isochrons in the $^{207}Pb/^{204}Pb$ vs. $^{206}Pb/^{204}Pb$ plot yield approximately the same age as proposed by WENDT et al. (1986) of about ± 311 Ma (Rb/Sr - Isochron).

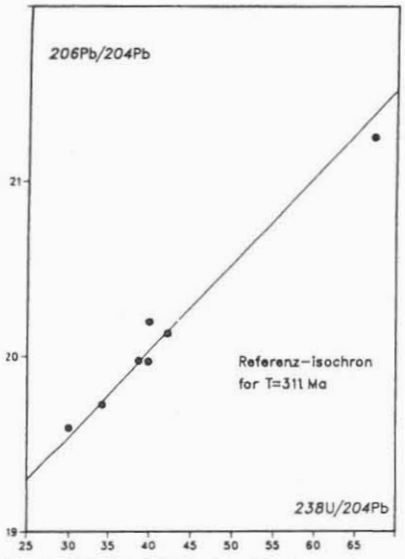

Fig. 3: U/Pb-plot of WR-data of the Falkenberg granite. Reference-isochron for T = 311 Ma intersects the lowest feldspar-value.

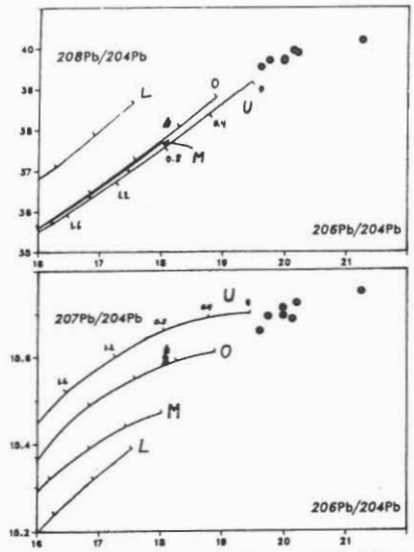

Fig. 1: Plot of analysed WR ● and feldspars ▲ of the Falkenberg granite. Superimposed are the Pb compositions (at 0,4 Ga intervals) of "upper crust"(U), "orogene"(O), "mantle"(M) and "lower crust"(L) taken from ZARTMAN + DOE (1981).

We tried to spread the Pb/Pb-isochron by leaching WR and feldspar as well as Bi and Ms of one sample (O-176, fig.2). The slope of this isochron is in good agreement with the slope of the isochron resulting from a plot, concerning all measured Pb-isotope-values.

The measured μ-value (WR) and the calculated μ-value (Pb-isotopes of Fd-WR pairs) agree with each other indicating that the U/Pb-system was closed since 311 Ma, as it can be illustrated by an U/Pb-plot of the WR-data (fig. 3).

The feldspar-leads of these granitic rocks form an extremly steep correlation-line (s > 0.8) which cannot be interpreted as a secondary isochron but only as a mixing-line.
Furthermore, this feldspar-lead correlates especially well with lineament-bound ore-lead from the Frankenwald and northern Oberpfalz (HÖHNDORF & DILL 1986, fig.4). This observation leads to the supposition that ore-lead as well as feldspar-lead were separated from the same source.

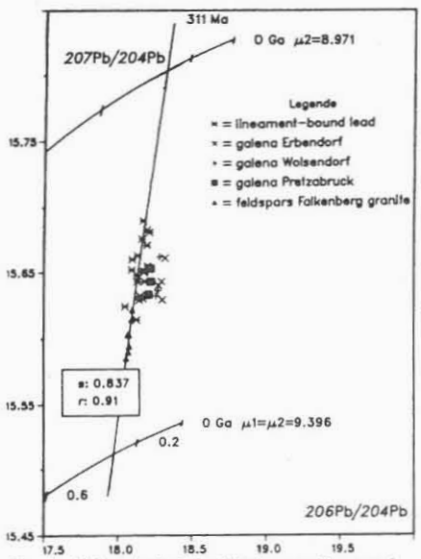

Fig. 4: Feldspar-leads of the Falkenberg granite compared with ore-lead of the Frankenwald and northern Oberpfalz (HÖHNDORF + DILL, 1986) and with calculated Pb-evolution lines (for explanation see text).

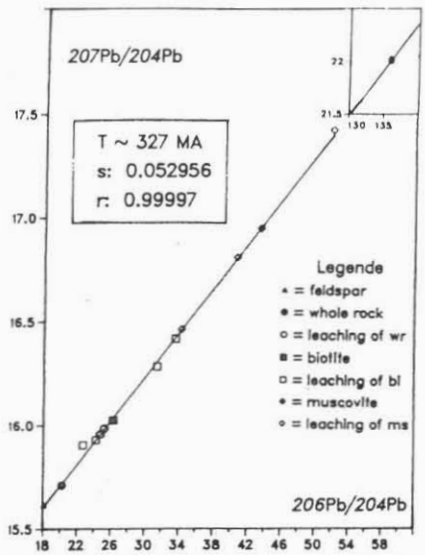

Fig. 2: Whole rock - mineral Pb/Pb-isochron on sample O-176

To explain the feldspar-correlation by mixing, several mathematical solutions are possible. We present a 3-stage evolution based on the STACEY & KRAMERS-model (1975). Stage 1 (4.57 to 3.7 Ga) assumes a constant μ_o= 7.19, stage 2 (3.7 to 2.4 Ga) evolves two units with different μ-values (unit A: μ_1=9.4, unit B: μ_1=11.0). Stage 3 is characterized by an uranium-removal of unit B (μ-decreasing to μ_2=8.97) at T_2=2.4 Ga, whereas unit A is not affected. If both units are mixed then at T_3=311 Ma they produce a mixing-line with a slope indentical to the presented feldspar-correlation (see fig.4).

Summary

The Pb/Pb-isochrons and the comparison between measured und calculated μ-values show a closed U/Pb-system for the Falkenberg granite.

The good correlation between lineament-bound ore-lead and feldspar-lead of the Falkenberg granite indicates a common source-mixing and separation ca. 320-310 Ma ago.

The chemical preparation of the samples was done in the clean-lab of the Geochemisches Institut in Göttingen. The isotope-measurements were carried out by mass-spectrometry (MAT 261) in the MPI f. Chemie in Mainz by kind support of Prof. A.W. Hofmann and Dr. W. Todt.

References

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