Estimating λ(^{40}K) by U-Pb and ^{39}Ar-^{40}Ar dating of the peralkaline Ilímaussaq complex, Greenland

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The Mesoproterozoic Ilímaussaq igneous complex comprises an extraordinary diversity of peralkaline rock types formed in three distinct magmatic events. The first one, augite syenite, was followed by alkali granite and, finally, nepheline syenites. Such extreme differentiates require a fast (< 0.1 Ma) differentiation process. Solidus temperatures reach down to 450 °C; intrusion depths were 3-4 km. Water activity was very low and no metamorphic overprint occurred. Therefore, all mineral ages are magmatic crystallization ages.

Baddeleyite is an early phase in the augite syenite: it occurs as euhedral inclusions in olivine, cpx, feldspar and Fe-Ti-oxides. U-Pb dating on 4 replicate baddelyite fractions from stage 1 augite syenites gave 1160 ± 5 Ma. This agrees with the zircon age of 1166 ± 9 Ma from stage 2 alkali granite [6].

Seven amphiboles were dated by ^{39}Ar-^{40}Ar: Ca-rich members from early augite syenites (ferro-edenite, ferro-pargasite) and Na-dominated arfvedsonite and nyböite from late agpaitic rocks. Very importantly, the Ar mass spectrometry was performed with the Faraday cup only, avoiding potential problems with multiplier nonlinearity. K-Ar ages calculated ages with the ^{40}K decay constant of Steiger & Jäger [5], $\lambda = 5.543 \times 10^{-10}$ a^{-1}, and relative to an MMhb-1 age of 523.1 Ma (i.e. an FCT age of 28.02 Ma [4]), are ca. 1145 Ma. In this case, one has to postulate a differentiation history with a gap of 15 Ma between the augite syenite and the other agpaitic rocks, which is unreasonable. This indicates that the λ used so far has to be re-examined (see also [1]).

Simultaneous optimization of the K-Ar monitor age with λ was proposed by [3]. Calculating the ages of our amphiboles using the values in [3], 28.27 ± 0.13 Ma and 5.476 ± 0.034 x 10^{-10} a^{-1}, respectively, makes them ca. 7 Ma older than the U-Pb ages. However, most of our samples show no indications for excess Ar or other disturbances of the Ar isotopic system.

The best agreement between K-Ar and U-Pb ages is obtained by reducing the FCT age to 28.15 Ma and increasing λ to 5.490 x 10^{-10} a^{-1}, in marginal agreement with those proposed by [3]. If one considers the FCT age as fixed at 28.24 ± 0.01 Ma [2], then the resulting λ is 5.503 x 10^{-10} a^{-1}.

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Calibration of the early Triassic biotic recovery: New U/Pb zircon ages from South China

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Calibration of the Early Triassic biotic recovery is presently only constrained by two zircon ages obtained for the Permian-Triassic boundary (252.6 ± 0.2 Ma, Mundil et al., 2004) and the Anisian-Ladinian boundary (≈ 241 Ma, Mundil et al. 1996, Palfy et al. 2003). The respective durations of the four Early Triassic stages (Griesbachian, Dienerian, Smithian, Spathian) and of the Anisian remain to be established. Preliminary new zircon ages obtained from ash beds intercalated with ammonoid faunas in the Luolo Fm (Early Triassic) and the overlying Baifeng Fm. (Anisian) in northwestern Guangxi (South China) lead to first estimates of the durations of the Spathian and of the Anisian.

Zircons were dated by precise isotope-dilution U-Pb techniques of mechanically abraded single-grains. In the upper carbonate unit of the Luolo Fm., zircons from the lower ash bed (basal Spathian) yield a crystallization age of 250.7 Ma, whereas those from the upper ash bed (Haugi Zone, latest Spathian) yield an age of 247.1 Ma. Zircons from an ash bed at the very base of the Baifeng Fm. (early Anisian) point to an approximate age of 246.4 Ma. Increased precision will be achieved by applying annealing-leaching procedures.

Hence, the Spathian/Anisian boundary is bracketed between 247.1 Ma and 246.4 Ma, which leads to a duration of the Early Triassic comprised between 5.5 and 6.2 my if adopting a P/T boundary age of 252.6 Ma. As the duration of the Spathian is no less than 3.6 my, this stage accounts for at least half of the duration of the Early Triassic. The duration of the Anisian is comprised between 5.4 my and 6.1 my when taking a 241 Ma Anisian/Ladinian boundary. Our new ages constrain the very high recovery rate of ammonoids, which had a first diversity peak during the Spathien.

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