

K-Ar ages, Pb isotopes and Geochemistry of Basalts from Ash Shaam Volcanic Field, NE Jordan

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The Ash Shaam (AS) volcanic field in NE Jordan is one of several Cenozoic volcanic fields situated on the western Arabian plate. In the frame of a joint project between the Geological Survey of Israel and the Natural Resources Authority of Jordan, K-Ar ages were determined on ca. 200 samples from AS, including fissure eruptions, volcanic centers, dikes and flows. Major, minor, trace and rare earth elements were determined on selected ca. 40 samples. The Pb isotopic composition was determined using MC-ICP-MS, in which ion exchange column chemistry procedure was adjusted to fit the MC-ICP-MS capabilities.

Sample ages range between 32 to 22 Ma and from 13 Ma to recent indicating a gap of ~10 Ma in the volcanic activity. This age distribution is in agreement with timing of activity at other volcanic fields in the Arabian plate.

Fissure eruptions bisect the AS and are commonly trending between 290° and 310° sub parallel to the Red Sea axis. The Qitar El Abid (QEA) lineament is the most prominent fissure eruption with a length of about 90 km. Ages along the QEA indicate activity in two major episodes - 12 to 8 Ma ago and 3 to 1 Ma ago.

Samples range in composition from basanite to alkali basalt and are relatively primary (#Mg = 0.59±0.05). MgO is correlated with CaO, Al₂O₃, Ni and Cr while SiO₂ is correlated with TiO₂, Na₂O, K₂O and La. Both MgO and SiO₂ behaviours may suggest strong control of partial melting on magma composition however, no correlation was observed between MgO and incompatible elements such as La. In addition, samples form a curved line on La vs. chondrite normalized ratio of La/Sm, which suggests mixing of at least two sources rather than partial melting.

The isotopic composition of Pb in 20 basalts spans a restricted range (²⁰⁶Pb/²⁰⁴Pb=18.8-19.4) and forms a linear array on the ²⁰⁸Pb/²⁰⁴Pb vs. ²⁰⁶Pb/²⁰⁴Pb plot, slightly above the Northern Hemisphere Reference Line (Hart, 1984). However, sample points are more scattered on ²⁰⁷Pb/²⁰⁴Pb vs. ²⁰⁶Pb/²⁰⁴Pb plot. The Pb isotopic composition is not related to chemical composition (e.g. (La/Yb)_N, Pb/Ce and La/Th), volcanic structure and ages. The isotopic composition of Pb from AS is within the field defined by other volcanic fields in the Arabian plate. However, the AS samples have a distinct isotopic signature.

An experimental study of the affect of aqueous fluoride on quartz, kaolinite, and alkali feldspar dissolution rates

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Far from equilibrium, steady state dissolution rates at pH 2 of quartz at 50 and 100° C, kaolinite at 50° C, K-feldspar at 50 and 100° C, and albite at 25° C have been determined as a function of aqueous NaF concentration up to 5x10⁻³ mol/kg from the results of experiments performed in mixed flow reactors. Dissolution rates of each of these minerals increase monotonically with increasing NaF concentration. Measured quartz dissolution rates are found to be consistent with the surface speciation model proposed by Dove (1994), and are successfully modelled assuming rates are proportional to the sum of two surface species concentrations: >SiOH⁰ and >SiOH₂F⁰. Measured kaolinite and alkali feldspar dissolution rates are found to be consistent with the general multi-oxide dissolution mechanism proposed by Oelkers (2001); these rates are successfully described using

$$r_{+} = k (a_{H^{+}}^3/a_{Al^{3+}})^n$$

where r_{+} represents the surface area normalised far from equilibrium rate, k refers to a rate constant, a_{i} denotes the activity of the subscripted aqueous species, and n defines a constant. The affect of aqueous fluoride is taken account in this mechanism through the lowering of aqueous Al³⁺ activity due to aqueous Al-F complex formation computed using aqueous species distribution codes. Values of the constant n obtained from data regression correspond closely to those reported from fluoride-free experiments at acidic conditions reported by Oelkers et al. (1994) and Devidal et al. (1997). This close agreement suggests this same mechanism can be used describe accurately the affect of other aqueous species on aluminosilicate dissolution rates.

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