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Fission track age determination of apatite from the Hormoz island, Iran

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Fission-Track-Altersbestimmung an einem Hormoz-Apatit, Iran.

Synopsis:

Mittels der in Innsbruck erweiterten Uranspaltspurenmethode wurde für eine Apatitprobe von der Insel Hormoz (Iran) ein korrigiertes Spaltspurenalter von (44 ± 9). 10^6a bestimmt, dem eine Temperatur von ≈45°C zugeordnet ist. Der Beginn der Salztektonik dieser Insel, der aus bisherigen feldgeologischen Untersuchungen nicht klar hervorgeht, reicht somit bis ins Eozän zurück und stimmt auch überein mit der Modellvorstellung von O'BRIEN über die Salzinfiltration in Südpersien.

Since FLEISCHER and PRICE (1964) for the first time demonstrated that apatite is suitable for fission track age dating, several scientists have used this method for various rock samples throughout the world. Ages thus measured have been found to be lower in general than ages of other minerals separated from the same sample and determined by K-Ar or Rb-Sr methods. This fact was attributed to thermal annealing of the fission tracks in the course of some thermal event or burial and uplift. Hence, interpretation of a fission track age must be limited to the time elapsed since the last thermal event.

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MÄRK et al. (1973) in extension to previous results (NAESER and FAUL (1969)) have made detailed studies of the thermal annealing behavior of fission tracks in apatite. They have found that there exists a linear dependence between the reduction of track lenghts l and the reduction of track densities p independently of annealing conditions. This result was used to correct thermally lowered fission track ages, yielding for ages $\cong 10^8$ yr a formula for the corrected age t:

$$t = \frac{p_s}{p_i} \cdot \frac{n \cdot \sigma_f \cdot I}{\lambda_f} \cdot \frac{\bar{l}_i}{\bar{l}_s}$$

with p_s and p_i being spontaneous and induced track densities, n being thermal neutron dose, σ_f cross section for thermal fission of ^{235}U (582 barn), λ_f decay constant for spontaneous fission of ^{238}U (1,01 ± 0,11) 10^{-16} a^{-1}(MÄRK et al.) I being ratio of the abundances of ^{235}U and ^{238}U (7,26 • 10^{-3}), and $\bar{l}_s$ and $\bar{l}_i$ being the mean spontaneous and induced fission track lengths.

Moreover, MÄRK et al. (1973) have derived a track fading law from their experimental data, which enabled them to calculate the temperature of the mineral sample at the time of the corrected fission track, assuming linear cooling down of the region.

Based on these findings, the fission track age of an apatite sample of the Hormoz island, Iran, was determined in the present study. Preparation, etching, and track counting of the samples has been described in detail by VARTANIAN (1975). The experimental results and data obtained are shown in table 1. Together with the measured ratio of $\bar{l}_i/\bar{l}_s$ = 1,18 ± 0,05 they yield a corrected fission track age of (44 ± 9) • 10^6 yr. The temperature at that time was calculated according to MÄRK et al. (1973), to be ~45°C.

Hormoz island is one of several islands at the entrance of the Persian Gulf. All of these islands are part of the great salt-dome province of Laristan. According to WOLF (1959), three groups of rock can be observed on the Hormoz island:

a) Hormoz series including all rocks brought to the surface by the saltdiapyrism and also those connected with igneous activity. The former consisting of sediments and intrusive igneous rocks of Cambrian and Ordovician age, the latter being clearly younger than the Cambrian sediments in which they were intruded. According to Wolf, however, the age of this volcanic and intrusive activity is not yet determined, but may be much younger than the Lower Paleozoic, if SCHROEDER's (1946) correlation with the Salt Range series of India is applied.

b) sediments of the Miocene Upper Fars series, which are pierced and tilted by the rising sultplug in the aftermath of the igneous activities. The age of this event is between Miocene and Plio-Pleistocene, because the oldest sediments unaffected by the salt diapyrism are Plio-Pleistocene

c) sedimental series of Plio-Pleistocene age

The present apatite sample originates from a mine in the south of the island, situated between a salt-dome and rim rocks. The apatite crystals (appr. 1,5 × 1,5 × 4cm) are cluft apatites, which were separated from the bedrock and transported by the above mentioned diapyrism. The present obtained temperature age of (44 ± 9). 10^6 yr with 45°C dates the cooling period of the rock series (see group a)) following the last vulcanic activities.

Thus this last volcanic activities, which foregoe the salt infiltration and whose age is not clearly deduceable from field geological arguments, dates back to the Eocene. This result shows the same relation between salt-diapyrism and volcanic activity as described by O'BRIEN (1957), where igneous intrusion of basaltic magma at some stage prior to late Ordovician time is followed by the cooling of the magma, which then opens fissures and allows the infiltration of salt.

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Table 1 Experimental results and data of apatite samples of Hormoz island, Persia

Sample Nr.	absolute number of counted tracks		track densities in 10^{+4} cm^{-2}		ratio p_s/p_i	thermal neutron dose in n • cm^{-2}
	spont.	ind.	p_s	p_i		
1	455	261	6,07 ± 0,28	3,48 ± 0,21	1,74 ± 0,13	5,8 • 10^{14}
2	454	289	6,05 ± 0,28	3,85 ± 0,23	1,57 ± 0,12	5,8 • 10^{14}
3	157	295	4,83 ± 0,39	14,22 ± 0,83	0,34 ± 0,03	2,2 • 10^{15}
4	165	286	4,72 ± 0,37	11,79 ± 0,70	0,40 ± 0,04	2,2 • 10^{15}

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