FISSION TRACK EVIDENCE FOR A MIOCENE COOLING EVENT, WHIPPLE MOUNTAINS, SOUTHEASTERN CALIFORNIA

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ABSTRACT

Fission track dating of metamorphic rocks from the Whipple Mountains, California indicates a previously unreported cooling event affected the region during the early Miocene. The timing of this event coincides with basaltic volcanism and the development of an enigmatic low-angle fault terrane that seems to be of regional proportions.

Metamorphosed granitic rocks and mylonitic gneisses lying along and structurally below the basal dislocation surface were sampled and their apatite, sphene, and zircon fractions dated. These mineral-thermometers have fission track retention temperatures that are sensitive within the range of 100° to 250° C.

Data from all the mineral phases were concordant and therefore, indicate a rapid cooling interval between 18 and 20 m.y. ago. Cooling intervals in the geologic record of the magnitude described here are indicative of a major, rapid uplift of an orogenic terrane. Although at present it is not possible to place the proposed uplift into the tectonic framework of the area, the timing of the event does coincide with major southern Cordilleran developments such as Basin and Range extension and basaltic volcanism.

INTRODUCTION

Fission track geochronology is one of the most valuable applications of Solid State Track Recorders (SSTR). Although ^{238}U primarily decays through a long sequence of alpha and beta disintegrations, a very small fraction of these atoms decay by <u>spontaneous</u> fission. This process, albeit extremely rare, is quite energetic (~200 MeV) and produces linear lattice damage zones that can be enlarged (10-20 μm) enough by chemical etching to be viewed by an ordinary petrographic microscope. The total remaining ^{238}U in the sample can be determined indirectly by inducing the fission of ^{235}U (~204 MeV) by thermal (slow) neutron bombardment. These <u>induced</u> tracks are revealed through the same process used to expose the sponateous tracks. The number of <u>spontaneous</u> and <u>induced</u> tracks on exactly the same surface area of a mineral are determined with a calibrated grid-style eyepiece. The apparent *age* of a mineral can be calculated by knowing the ratio of these track densities and the thermal neutron dose (fluence) that produced the induced tracks. Fleischer and others (1975) review the theory, techniques, and applications of fission track systematics, in addition to the entire field of solid state track recorders.

In that fission tracks are thermally sensitive daughter recording systems (analogous to K/Ar(mineral) and Rb/Sr(mica)), each <u>age</u> represents the time when a given mineral cooled through a particular narrow temperature range. This track retention threshold is a function of the mineral species, cooling rate, and the time interval over which the mineral was cooled. Most igneous and metamorphic rocks contain several accessory mineral-thermometers that can be used to chronicle its thermal history. For example, dated minerals from a volcanic rock will yield concordant fission track ages that reflect the time of crystallization. Concordant mineral ages from plutonic bodies have been shown to have tectonic significance in indicating the time of uplift (Wagner and others, 1977; Dokka and Frost, 1978; Naeser, 1978), while plutonic bodies with a more protracted cooling history will yield a set of discordant ages. Table 1 presents the current estimates on fission track retention temperatures for the minerals examined herein. Wagner and others (1977) and Harrison and others (1978) have recently discussed the thermal considerations of fission track recording.

GEOLOGIC RELATIONSHIPS

The location, generalized geology, and fission track sampling localities for the Whipple Mountains are shown on Figure 1. This range contains a diverse group of lithologic types ranging from Precambrian to Late Cenozoic in age. The areal distribution of these units has been greatly affected by an early(?)-middle Miocene interval of low-angle faulting (Lingrey and others, 1977). Rocks in the eastern Whipple Mountains can be grouped into three lithotectonic packets reflecting similarity in composition, deformation, and position relative to a basal dislocation surface. These tectonic packets include: a lower plate mylonitic complex, an upper plate crystalline complex, and Late Tertiary continental deposits (Lingrey, 1978; K. Evans, written communication, 1978). An impresive, flat-lying fault (basal dislocation surface) separates the lower plate mylonitic rocks from the overlying upper plate crystalline rocks and Late Tertiary continental deposits.

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