CENOZOIC TECTONIC HISTORY OF THE SOUTHERN TIBETAN PLATEAU AND EASTERN HIMALAYA: EVIDENCE FROM $^{40}Ar/^{39}Ar$ DATING

by

Peter Copeland

a dissertation
submitted to the State University of New York at Albany
in partial fufillment of
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Doctor of Philosophy

College of Sciences and Mathematics
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ABSTRACT

The collision between India and Asia began between 40 and 55 million years ago. At that time southern Tibet was at an elevation very near sea level; the Tibetan plateau today has an area of over 700,000 km^2 and an average elevation of ~5000 m and is underlain by continental crust with a thickness of 65-75 km. During the collision India has continued to move northward relative to Siberia at ~5 cm/year. The tectonic mechanisms by which the continued convergence has been accommodated within Asia have varied considerably in both time and space. This dissertation concerns rocks from three distinct areas, southern Tibet, central Nepal, and the southern Bengal Fan, and relates geochronologic data from these rocks to the tectonic history of the India-Asia collision in southern Tibet and the eastern Himalaya.

In the area of Tibet around Lhasa thermochronologic data from plutons of the Gangdese batholith suggest that the cooling histories of these rocks have varied considerably since 40 Ma. These cooling histories can be linked to the unroofing of these rocks and, in some cases, to the uplift of the surface of the earth relative to sea level. In two plutons, Quxu and Pachu, there exists evidence for brief (< 1 million years) episodes of rapid unroofing (> 4 mm/year) at approximately 18 Ma and 14 Ma, respectively. Excepting significant tectonic denudation by normal faulting, for which there is no evidence, these rates of unroofing could not have been maintained without substantial relief. Therefore, the results from Quxu indicate that the southern margin of the Tibetan plateau had begun to be a prominent topographic feature by the early Miocene. The episodic nature of the unroofing of these plutons indicates that the uplift of the southern Tibetan plateau varied in both space and time.

^{40}Ar/^{39}Ar dating of detrital K-feldspar and muscovite from the southern Bengal fan (ODP Site 116) also illustrates the episodic nature of the uplift and erosion of the Himalaya and southern Tibet. Four to 13 K-feldspars and muscovites were dated from each of seven stratigraphic levels which represent the past 18 million years of sedimentation. In every level at least one K-feldspar and one muscovite had minimum ^{40}Ar/^{39}Ar apparent ages equal to the stratigraphic age. Because we can rule out the possibility of a volcanogenic origin for this material and because of the paucity of deep crustal rocks in the source area, these results indicate that many distinct portions of the provenance area of the Bengal fan have experienced rapid erosion (> 5mm/year) during the past 18 million years.

U-Pb dating of a granite which cross-cuts a fault near Mt. Everest indicates that this fault was active prior to 20 ± 1 Ma. This struture has been interpreted to be the result of gravitaional collapse of a high-standing Tibetan plateau and, under this interpretation, this result suggests significant uplift of the southern Tibetan plateau by the Early Miocene. The isotopic results from this sample suggest a closure temperature of Pb in monazite of ~720-750 °C, significantly higher than previous estimates.

There are a series of N-S trending grabens in southern Tibet which have been interpreted to be the result of the Tibetan plateau spreading under its' own weight. The Nyainqentanghla mountain range bounds one of these grabens; thermochronologic data from this range suggest that this graben began forming before 5 Ma and perhaps before 10 Ma. This suggests that the southern Tibetan plateau achieved an elevation and crustal thickness similar to its present day values by the end of the Miocene.

^{40}Ar/^{39}Ar dating of the Manaslu granite together with the new appreciation of the behavior of Pb in monazite suggests the Manaslu granite is composed of a group of isotopically diverse batches of magmas which coalesced over a brief period of time at ~20 Ma. Thermochronologic data from rocks of the Greater Himalayan Crystallines and the Lesser Himalaya Formations, south of the Manaslu granite, indicate a profound thermal disturbance centered on the Main Central Thrust at the end to the Miocene. This disturbance is interpreted to be the result of the passage of hot fluids through the MCT zone at about this time. These fluids reamained at peak conditions between 500,000 and 1 million years. The fluids are thought to be a result of thrusting of hot hanging wall rocks of the Main Boundary Thrust over colder footwall rocks, inducing dehydration in the latter. This is essentially the same model which has previously been suggested for the production of the High Himalaya granites, such as the Manaslu granite, by dehydration of the footwall of the MCT.

The data presented here do not favor tectonic models for the Tibetan plateau in which the uplift proceeds at an even pace nor those in which most of the uplift takes place in the past 5 million years. The available data do permit models in which much of the convergence in the Oligocene is acccommodated by continental escape, the Miocene is dominated by crustal thickening of the Tibetan plateau, through distributed shortening, and the past 5 million years have included E-W extension, continental escape, crustal thickening, and incipient plate re-orginization.

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The samples analyzed in this study come from three diverse locations; the samples discussed in the individual chapters were collected by the following individuals: Ch. 2.: W.S.F. Kidd; Ch 3: P. Copeland, W.S.F. Kidd, and T.M. Harrison; Ch. 4: B.C. Burchfiel, K.V. Hodges, and L. Royden; Ch. 5&6: P. Le Fort and A. Pêcher, Ch. 7: W.S.F. Kidd; Ch. 8: P. Copeland, W.S.F. Kidd, and T.M. Harrison; Ch. 9: W.S.F. Kidd; Ch. 10: J. Corrigan and J. Cochran.

Randy Parrish, Canadian Geological Survey, performed the U-Pb analysis in Chapter 4; the important contribution in this chapter is a direct reflection of his careful and patient work. Carl Wirth, Cornell University, did the neutron activation analysis on sample Δ33. The XRF analysis in this chapter was done at McGill Univeristy through the assistance of John Delano.

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