UNROOFING HISTORY AND STRUCTURAL EVOLUTION OF THE SOUTHERN LHASA TERRANE, TIBETAN PLATEAU: IMPLICATIONS FOR THE CONTINENTAL COLLISION BETWEEN INDIA AND ASIA

by

Yun Pan

A Dissertation

Submitted to the State University of New York at Albany

in Partial Fulfillment of

the Requirements for the Degree of

Doctor of Philosophy

College of Sciences and Mathematics

Department of Geological Sciences

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ABSTRACT

A fission track and $^{40}Ar/^{39}Ar$ thermochronology study of plutonic and volcanic rocks from the Gangdese magmatic belt, southern Tibet, gives evidence for average cooling rates of 4 - 10 °C/Ma (54-0 Ma) and unroofing rates of 0.1 - 0.3 mm/y for this part of the Gangdese batholith. Linzizong volcanics of the Gangdese belt in the Maqu area have experienced deep burial and slow cooling, and an unroofing rate of ~0.3 mm/y was obtained for the period of 40-55 Ma. It is confirmed that there has been a pulse of unroofing (>3 mm/y) at 20-15 Ma in the Quxu pluton of the Gangdese batholith based on fission track and $^{40}Ar/^{39}Ar$ K-feldspar modeling results. It is evident from fission track data that this pulse was also experienced by plutons north of the Quxu area. These data suggest that onset of intense uplift of southern Lhasa terrane was long after (20 Ma later than) the beginning of collision between India and Asia, and that the uplift has been episodic rather than steady. Therefore, some tectonic models of the India-Eurasia collision, such as *Continental Underthrusting*, and *Continental Injection*, are not favored by these data.

New information on the eruption ages of the volcanic rocks in the southern Lhasa terrane has been obtained. An eruptional age of 50 ± 0.6 Ma of the upper part of Linzizong sequence is indicated by a flat K-feldspar $^{40}Ar/^{39}Ar$ age spectrum. The lower part of the Linzizong sequence may have been formed 60-65 Ma ago. Miocene age (~15 Ma) volcanic rocks in Majiang area were found to be conformable with conglomerates containing pebbles of Gangdese magmatic rocks, showing that this molasse deposit is middle Miocene in age.

Detailed structural mapping in the Maqu area suggests that the total crustal shortening in the Linzizong Formation is about 15-25 %, and the minimum shortening in the Cretaceous Takena Formation and older sediments is about ~40 % along the Maqu and Ganden sections. A biotite sample from a post-deformation diorite stock in the

Takena Formation yields a flat age spectrum of ~65 Ma, with an isochron age of 65.6 ± 1.9 Ma. This requires that the crustal shortening represented by the deformation in the Takena formation occurred prior to the start of the India-Asia collision.

A major low-angle ductile shear zone, containing S-C mylonites, involves metamorphosed granitic rocks at the southeastern edge of the Nyainqentanglha mountain range. Kinematic criteria consistently indicate a top-to-SE sense of shear. FT and $^{40}Ar/^{39}Ar$ data suggest very young ages (9-0 Ma) and rapid cooling (up to ~200 °C/Ma) of the footwall rocks. This shear zone and associated metamorphic rocks are interpreted as a metamorphic core complex structure. The timing of deformation suggests that the extensional tectonics in this area started at 8 ± 3 Ma, which in turn may indicate that the maximum sustainable crustal thickness was reached in southern Tibet around this time.

A substantial E-W striking and N-dipping ductile shear zone was found within granitic rocks of the Gangdese plutonic belt, in the Quxu area, just north of the Indus-Zangbo suture. Prominent stretching lineation lies on the foliation and is parallel to the dip direction. Quartz c-axis fabrics show strongly asymmetric patterns within the shear zone. Kinematic indicators suggest a top-to-north sense of shear. The lower grade phyllitic rocks in the northern part of this shear zone have been sheared into phyllonites. It is suggested that the shearing deformation occurred between 30-40 Ma, not long after the emplacement of the Quxu pluton. We interpret this shear zone as a N-S extensional fault in the upper crust, and its origin is probably similar to that of the younger, large-scale, E-W trending low-angle normal faults documented in the Higher Himalayas to the south of the suture zone.

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