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A review of Himalayan stratigraphy, magmatism, and structure

Aaron J. Martin

División de Geociencias Aplicadas, IPICYT, CP 78216 San Luis Potosi, Mexico

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ABSTRACT

The Himalayan Orogen consists of two rock packages that parallel the topographic trend of the mountain belt between the eastern and western syntaxes. To avoid confusion with appellations previously used to identify elevation, Cenozoic metamorphic grade, or Cenozoic structural position, in this paper I introduce new names for these rock packages: Himalayan Assemblage A and Himalayan Assemblage B. Inclusion in an assemblage signifies that there was physical contiguity between adjacent members of the assemblage at the time of deposition or intrusion. Assemblage A and Assemblage B may not have shared depositional or intrusive relationships prior to Early Cretaceous time.

Himalayan Assemblage A mostly consists of sedimentary rocks deposited on the northern margin of India; the depositional substrate for these strata is not exposed anywhere in the orogen. Assemblage A comprises three main groups of rocks divided based on age of deposition or intrusion: Paleoproterozoic to Early Mesoproterozoic, Late Carboniferous to Permian, and terminal Cretaceous to Pleistocene. The oldest rocks exposed in the Himalaya, ca. 1900–1800 Ma clastic deposits and the ca. 1880–1830 Ma granite and gabbro that intruded them, may have formed in a continental rift setting. This rift system established depositional strike toward the northeast, at a high angle to the strike of Cenozoic thrusts in the western Himalaya, with obliquity decreasing eastward. The succeeding Upper Paleoproterozoic to Lower Mesoproterozoic strata were deposited in a passive margin setting or, alternatively, in an epi-cratonic basin. Upper Carboniferous to Permian strata are called the Gondwana Group; these deposits are present only in the eastern half of the orogen. This package is dominantly clastic and probably was deposited in extensional basins related to the breakup of Pangea. Depositional strike of the Gondwana Group was likely between 25° and 50° west of north. Upper Paleocene to Pleistocene, dominantly clastic, strata were deposited in the Himalayan foreland basin. Along the central two-thirds of the orogen, depositional age uncertainties extend the possible depositional ages of the lowermost of these strata into the latest Cretaceous Period. If the lowermost strata of this package were deposited only in the Paleogene Period, they may be earliest Himalayan foreland basin strata, in contrast to current interpretations that formation of their depositional basin was unrelated to the Cenozoic Himalayan orogeny. Depositional strike paralleled the strikes of the Cenozoic Himalayan thrusts.

Between the syntaxes, most Pliocene to Holocene Himalayan thrust faults are contained in Assemblage A rocks. Most of these Pliocene to Holocene thrusts broke new paths through Assemblage A, they did not reactivate ancient high strain zones except possibly in the eastern Himalaya. The lack of reactivation in the western and central Himalaya may have resulted from unfavorable orientations of the ca. 1900–1800 Ma rift-related high strain zones relative to the direction of Cenozoic convergence. The Shillong Plateau is the only location between the syntaxes where deformation jumped far forward of the main thrust belt. There, the plateau-bounding Dauki Thrust is interpreted to have reactivated Cretaceous rift-related normal faults. The Dauki Thrust is broadly parallel to slightly oblique to nearby Paleoproterozoic normal-sense high strain zones. It is possible that these Paleoproterozoic normal-sense high strain zones were reactivated during both Cretaceous rifting and Cenozoic thrusting.

Salients and recesses in Himalayan frontal thrusts between the syntaxes have small amplitudes and wavelengths compared to their counterparts in many other Phanerozoic orogens. Three factors that contribute to these small map-view bends are: (1) The absence of a Mesozoic or Cenozoic magmatic arc and back-arc in the Himalayan foreland, in contrast to the northern Canadian Cordillera. (2) Unfavorable orientations of large stratigraphic thickness changes in the foreland, possibly except in the eastern Himalaya, in contrast to the Appalachian Orogen. (3) Unfavorable orientations of ancient high strain zones for reactivation, again possibly except in the eastern Himalaya, in contrast to the Appalachians.

Himalayan Assemblage B consists of Neoproterozoic to Pleistocene strata that were intruded by granite at ca. 880–800, 510–460, and 28–14 Ma. In northern Pakistan and northwestern India, granite also intruded at ca.

E-mail address: aaron.martin@ipicyt.edu.mx.

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290–260 Ma, contemporaneous with deposition of Panjal Traps basalt in the western Himalaya. The possible depositional substrate for Assemblage B may be exposed only in a small area in northwestern India, where lowermost Assemblage B strata may have been deposited on the ca. 1850 Ma Baragaon granitic gneiss.

Himalayan Assemblage B satisfies all three parts of the definition of a suspect terrane: It has an internally consistent geologic history, its pre-Cretaceous geologic history differs significantly from the histories of neighboring rocks, and it is separated from neighboring rock packages by high strain zones. Himalayan Assemblage B may have been located north of western Australia from Neoproterozoic to Middle Jurassic time. During Late Jurassic to Early Cretaceous time, a system of left-handed transcurrent faults may have juxtaposed Assemblage B against rocks of the northern Indian Shield, including Assemblage A. The Miocene Main Central Thrust reactivated this transcurrent fault system and, between the syntaxes, continued to juxtapose Assemblage A and Assemblage B in its footwall and hanging wall, respectively. In this scenario, the Main Central Thrust did not repeat pre-Cretaceous stratigraphy because the footwall and hanging wall assemblages did not share depositional contiguity prior to the Early Cretaceous Epoch.

The Namche Barwa and Shillong Plateau/Mikir Hills areas have pre-Cretaceous geologic histories distinct from Assemblage A and Assemblage B and the pre-Cretaceous rocks of these two regions thus do not belong to either assemblage. The Namche Barwa and Shillong Plateau/Mikir Hills rocks were deformed, metamorphosed, and intruded in the Mesoproterozoic Era along with rocks of the Central Indian Tectonic Zone–Chhotanagpur Gneissic Complex–North Singhbhum Mobile Belt. The Namche Barwa and Shillong Plateau/Mikir Hills rocks additionally were affected by the late Ediacaran to Cambrian Kuunga Orogeny, as also recorded in the Eastern Ghats. Cambrian strata of eastern Assemblage A may have been deposited in a foreland basin in front of the Kuunga Orogeny, like similar-age deposits in the Shillong Plateau/Mikir Hills and Namche Barwa areas.

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