Notes

EARLY TO MIDDLE PROTEROZOIC FOLD BELTS

A meeting of great significance to Indian geologists was held in Darwin, Australia, in August of 1985. The topic was 'Early to Middle Proterozoic Fold Belts,' and the focus was on the distinction between *inter*-cratonic and *intra*-cratonic mobile zones. Because the Indian peninsular shield contains a number of areas that have been stable since Archean or early Proterozoic time, bounded by middle to late Proterozoic mobile belts, the issues discussed at Darwin should be summarized in this journal.

The case for *intra*-cratonic development of mobile belts was made early in the meeting by a group of geologists from the Australian Bureau of Mineral Resources, Geology and Geophysics, the principal organizer of the conference. They divided the Australian shield into a number of old, probably largely Archean, stable areas transected by younger mobile belts. Most of the mobile belts were active from about 1,900 to 1,500 m.y. ago. Orogenic episodes followed a consistent pattern in all of the belts, with initial localized rifting, volcanism and sedimentation, later broad-scale subsidence, and ultimate compression and felsic magmatism. Some of the deformation associated with the belts may have been the result of detachment (low-angle normal) faulting rather than thrusting. Repetition of the sequence of events has been demonstrated in some belts.

This concept of intra-cratonic mobile belts does not include formation of oceanic crust within the rifts and subsequent subduction of oceanic lithosphere, as is characteristic of many Phanerozoic orogenic belts. Evidence in favour of the intra-cratonic model includes: 1) sedimentary sequences were derived from continental crust and lack typical graywackes or other oceanic/arc suites; 2) volcanic assemblages are felsic and commonly bimodal in silica contents; 3) plutonic rocks associated with deformational phases are more alkalic than typical subduction-zone batholithic assemblages; 4) ophiolites, melange zones, and related suites are absent; and 5) sequential development of mineral assemblages shows that cooling from peak metamorphic temperatures was essentially isobaric. The last observation indicates that the compressional event did not develop a thick mountain root, which would undergo isostatic uplift during cooling and consequent synchronous decrease in both temperatures and pressures.

The intra-cratonic model was both challenged and supported by geologists from other parts of the world. In particular, geologists working in North America tend to explain the evolution of orogenic zones in terms of an *inter*-cratonic model of plate tectonics, involving subduction of oceanic lithosphere, compression of continental-margin volcano-sedimentary assemblages, intrusion of calcalkaline batholiths, and possible collision of two continental blocks. The process generates ophiolites and related suites in Phanerozoic belts, but it is not certain that such materials would be emplaced or preserved in Proterozoic orogens. Intense compression is clearly easier to explain by such a process than by intra-cratonic activity.

The major issue in the discussions of the two models was whether there really are two different types of mobile belts (inter- and intra-cratonic) or whether all belts are similar and are simply perceived to be different by geologists with different backgrounds or who are working in different terrains. Possibly, North American geologists look for Precambrian subduction zones because North America has been virtually surrounded by such zones at numerous times during the Phanerozoic. Conversely, the restriction of Phanerozoic subduction in Australia to the east coast may have reduced the tendency of Australian geologists to explain older events by such a process. The controversy is currently unresolved.

Regardless of interpretation, one major consistency is being discovered in Precambrian terrains. An age of 1,900 to 1,800 m.y. has been documented for geochronologic events throughout Australia and also in numerous other shield areas. Clearly, this period represents a time of major activity in the earth. It is interesting to note, however, that this age is not well recorded in India. This discrepancy may imply that the Indian shield had a Precambrian history that was different from that of other shields, although it is also possible that there has been insufficient geochronologic work in India to demonstrate the importance of that age.

The significance of the various issues for Indian geologists is clear. Orogenic belts, with or without rift valleys, separate several discrete blocks in the Indian shield. Examples are: 1) the Satpura belt and the Narmada-Son lineament between the Aravalli/Bundelkhand area and the Bhandara and Singhbhum cratons; and 2) the Eastern Ghats front, on the western margin of the Eastern Ghats granulite terrain. Limited geochronologic information indicates that most belts were active around 1,500 m.y. ago. Are these 'orogenic belts' simply the result of compression and thrusting within a stable shield? Must they represent closure of an ocean basin, possibly implying development of the shield by accretion of formerly disparate blocks? Do the Indian rift valleys represent fracturing of crust following orogenic compression? Are the Indian mobile belts really younger than apparently similar belts in other shields? These fundamental questions about the various mobile zones provide exciting research opportunities.

Department of Geology 029A
University of North Carolina
Chapel Hill, NC 27514 USA

JOHN J. W. ROGERS