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Structural and geochronologic data from the Shin Jinst area, eastern Gobi Altai, Mongolia: Implications for Phanerozoic intracontinental deformation in Asia

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Abstract

The complex geology of central Asia records significant Phanerozoic growth and deformation of continental lithosphere, yet many questions about the timing and mechanisms of these processes remain. The Gobi Altai of southwestern Mongolia preserves much of this history in exposed mountain ranges and sedimentary basins. The Shin Jinst area (near latitude 44 21’ to 44° 32’, longitude 99°35’ to 99° 25’) contains important evidence of Paleozoic growth and accretion as well as subsequent Mesozoic and Cenozoic deformation. Detailed mapping and structural data, including data sets on folds and cross-cutting faults, point to repeated episodes of deformation and add to recent work that documents Triassic and Jurassic compression as well as Cenozoic tectonic activity in this region. New $^{40}Ar/^{39}Ar$ data are interpreted to record Permian to Jurassic convergent margin processes. In particular, these data, in combination with previous studies, suggest that southern Mongolia records protracted deformation throughout the Jurassic that likely resulted from compression associated with the subduction zone at the southern margin of Asia at that time.

Keywords: $^{40}Ar/^{39}Ar$ dating; Convergent margin; Southern Mongolia; Jurassic; Paleozoic; Strike-slip

1. Introduction

Asia records a complex Phanerozoic geologic history of the growth and repeated deformation of continental lithosphere (Fig. 1; e.g., Sengör et al., 1993; Heubeck, 2001; Hendrix and Davis, 2001a; Windley et al., 2007). Paleozoic strata record the development and growth of volcanic arcs and associated basins, as well as the amalgamation of these arcs and possibly smaller continental blocks, in several regions of Mongolia, Inner Mongolia, and northwestern China (e.g., Coleman, 1989; Lamb and Badarch, 2001; Heubeck, 2001; Badarch et al., 2002; Xiao et al., 2004; Windley et al., 2007). The Mesozoic and Cenozoic eras were a time of subsequent deformation of this recently formed continent (e.g., Hendrix and Davis, 2001b). Many workers have turned to Asia in the last 25 years as the premier natural laboratory for studying the growth and intracontinental deformation of continents. This is in part because these processes have happened during the Phanerozoic and, thus, the evidence is preserved and well-exposed. Much of the initial focus was on the ongoing India–Asian continental collision and the Himalayan and Tibetan uplift (e.g., Molnar and Tapponnier, 1975; Peltzer and Tapponnier, 1988; Houseman and England, 1996; Hodges, 2000). In the last decade, however, many have turned to the Paleozoic and Mesozoic evidence to help unravel the history of Asia and begin to understand the details of intracontinental deformation (e.g., Yin and Harrison, 2000; Hendrix and Davis, 2001b).

One especially intriguing feature of Asia is the large distance between the zone of deformation and the presumed area where tectonic driving forces are at their maximum (e.g., Hendrix and

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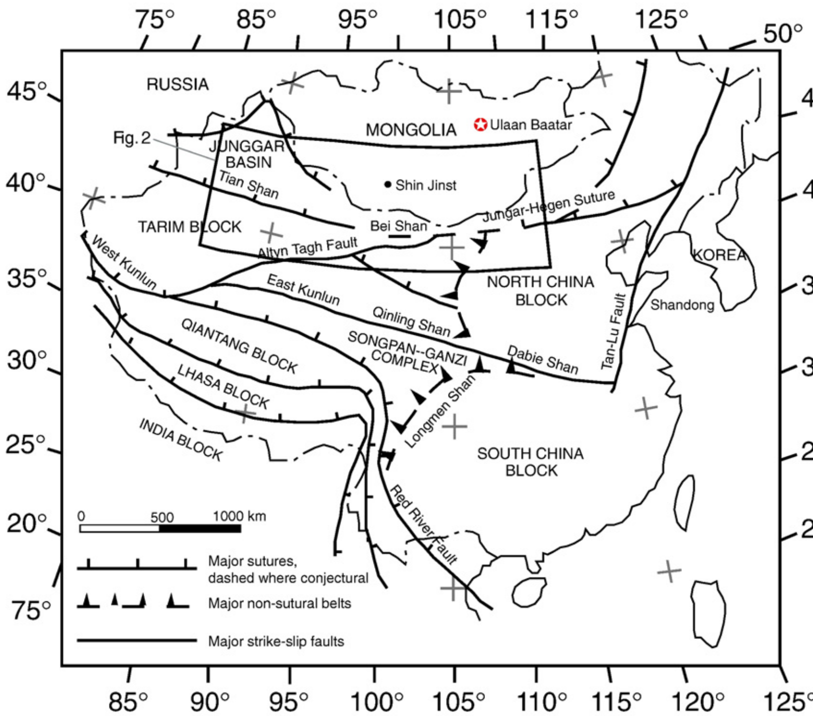

Fig. 1. Simplified tectonic map of Asia (after Dumitru and Hendrix, 2001). Box shows location of Fig. 2.

Davis, 2001b). Molnar and Tapponnier (1975) recognized far-reaching deformation associated with the ongoing collision between India and Asia three decades ago and many others have gone on to document this throughout central Asia (e.g., Hodges, 2000; Yin and Harrison, 2000). The processes by which this occurs, however, continue to be an area of current research and debate. For example, most workers in Asia accept that at least 1500–2000 km of convergence has occurred between India and Asia and that this convergence may have been accommodated by a combination of extrusion tectonics (e.g., Tapponnier et al., 1982; Peltzer and Tapponnier, 1988) and internal deformation (e.g. England and McKenzie, 1982; England and Houseman, 1986). The relative contribution, however, of different mechanisms at different times during the last 50 million years is an area of considerable ongoing research (e.g., Replumaz and Tapponnier, 2003; Cowgill et al., 2004a; Yue et al., 2005). Another area of

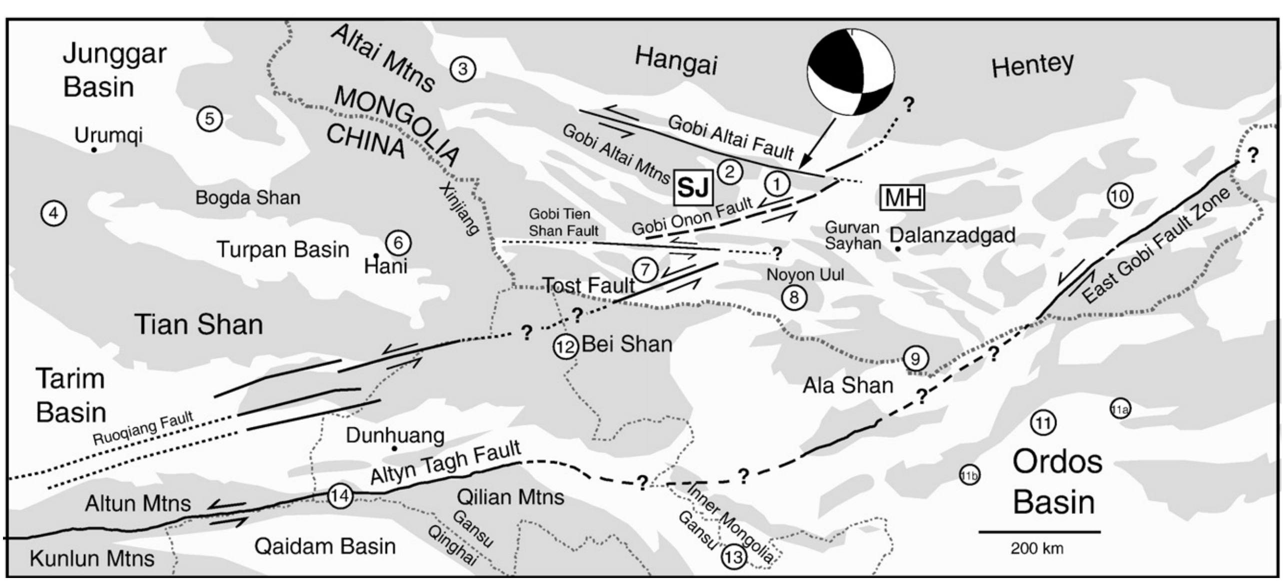

Fig. 2. Map of central Asia (after Lamb and Badarch, 2001) including Mongolia, including southern Mongolia and portions of Inner Mongolia, Gansu, Qinghai and Xinjiang provinces of China, with major faults and focal-mechanism solution from the December 4 1957 earthquake (Baljinnyam et al., 1993) discussed in the text. Shaded areas denote present mountains and elevated topography; white areas denote present basins. SJ and MH mark the Shin Jinst and Mushgai regions. Circled numbers refer to areas discussed in the text and used in Fig. 12.