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The crustal assembly of southern Mongolia: New structural, lithological and geochronological data from the Nemegt and Altan ranges

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ABSTRACT

The Gobi Altai region is an ideal setting for studying processes of continental growth and subsequent intracontinental and intraplate deformation, including terrane accretion and dispersal, ophiolite obduction, crustal reactivation and intraplate mountain building. To assess the diverse tectonic evolutionary models of the Gobi Altai and the wider region, more field data and geochronological data are required to constrain the tectonic evolution of individual terranes, and the relationship of adjacent crustal domains to each other throughout time. In this paper, we present new lithological, structural and $^{40}Ar/^{39}Ar$ age data, which constrain the crustal evolution across a previously unreported late Paleozoic terrane boundary in the Gobi-Altai. Nemegt and Altan Nuruu are topographically linked mountain ranges that were formed by Miocene-recent uplift at a right-stepping restraining bend along the left-lateral Gobi–Tien Shan Fault System in southern Mongolia. Ordovician–Carboniferous arc rocks and an ophiolite are exposed in the mountain ranges and form a small part of the east–west arcuate Trans-Altai Zone. Field observations of rock types and structures, combined with petrographic data are used to distinguish metamorphosed volcano-sedimentary arc rocks in Altan Nuruu and western Nemegt Nuruu from arc rocks in central and eastern Nemegt Nuruu. These distinct sequences are correlated with the Dzolen and Edrengin terranes in the Trans-Altai Zone along strike to the west. Integration of field data, $^{40}Ar/^{39}Ar$ age data and published studies are used to describe a polyphase deformation history that includes late Carboniferous ophiolite obduction, mid-Permian to late Triassic shortening and lateral terrane redistribution, Cretaceous rifting and late Cenozoic intraplate mountain building.

1. Introduction

The Central Asian Orogenic Belt (CAOB) is the location of the most extensive Phanerozoic continental growth on Earth and consists of a complex collage of Neoproterozoic to Paleozoic terranes covering an area greater than 4.5 million km^2 (Xiao et al., 2009a; Rojas-Agramonte et al., 2011). The Gobi Altai Mountains, in southern Mongolia, occupy a core position within the CAOB, sandwiched between the Precambrian blocks underlying the Hangay Dome to the north, and the Composite Tarim-North China craton to the south (Fig. 1, inset). The Gobi Altai region is an intracontinental and intraplate orogen that formed in the Late Miocene–Recent as a distant response to the Indo-Eurasia collision 2500 km to the south (Tapponnier and Molnar, 1979). Geologically youthful, long and narrow mountain ranges expose older basement rocks, which record a polydeformational history starting with Paleozoic terrane accretion and culminating in modern mountain building. The mountains are separated by broad basins, giving the region a basin and range physiography. The arid conditions and sparse vegetation mean that there is excellent rock exposure. This makes the Gobi Altai region an ideal setting for studying rocks and geological structures formed by processes of continental growth and subsequent intracontinental deformation, including terrane accretion and dispersal, ophiolite obduction, crustal reactivation and intraplate mountain building (Lamb and Badarch, 2001; Badarch et al., 2002; Windley et al., 2007; Cunningham, 2010; Glorie et al., 2011).

In order to document the complicated spatial and temporal evolution of the CAOB, it is important to determine the lithotectonic evolution of all its major terranes, the structural nature of terrane boundaries, and timing of major accretion and amalgamation events. However, in large parts of the CAOB, compared to, for example, the North American terrane collage (e.g. Coney, 1989), there are few studies of the terrane amalgamation history, and large regions are frontier areas that remain virtually unstudied. In this study, we present new lithological, structural and $^{40}Ar/^{39}Ar$ data for Nemegt and Altan Nuruu, a pair of topographically linked late Cenozoic uplifted mountain ranges in the southern Gobi Altai (Figs. 1, 2). Nemegt and Altan Nuruu represent a structural and metamorphic culmination in the southern Gobi Altai region and contain an important mid-late

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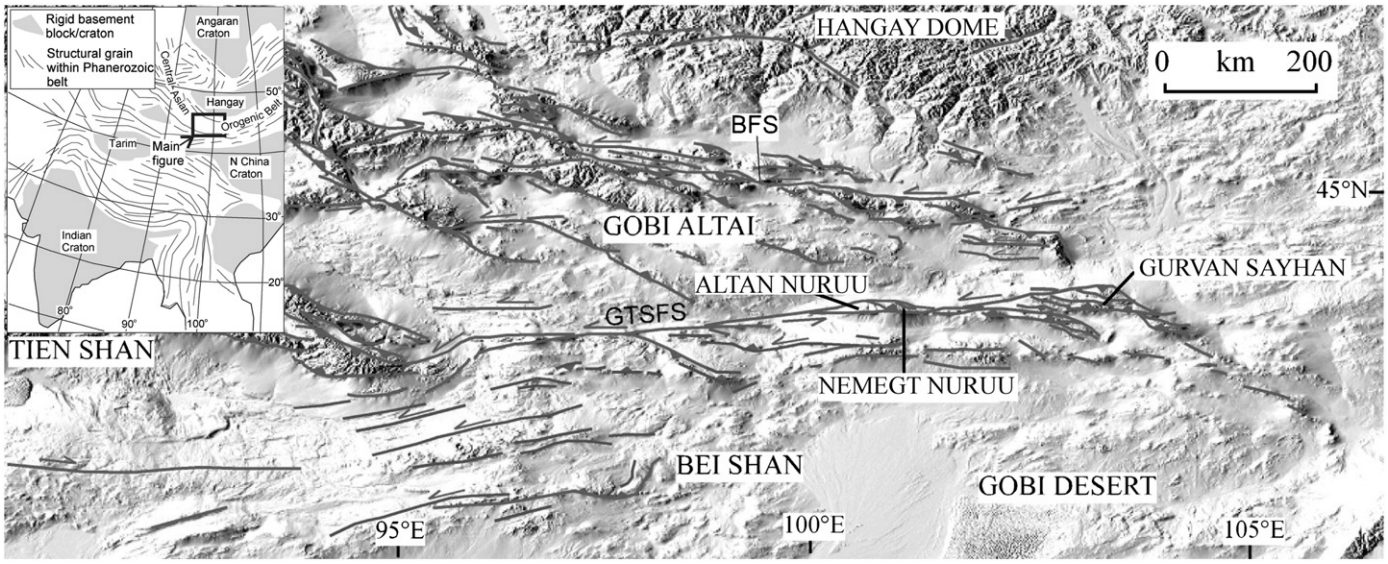

Fig. 1. Digital topographic map of southern Mongolia showing major fault zones and mountain ranges. Inset shows the location of southern Mongolia in the context of the Central Asian Orogenic Belt. GTSFS = Gobi–Tien Shan Fault System.

Paleozoic arc–arc terrane boundary and ophiolitic suture. Late Cenozoic mountain building in Nemegt and Altan Nuruu is only the latest event in a polyphase history that includes Silurian–Devonian arc volcanism, late Carboniferous arc accretion and ophiolite obduction, Permian to Triassic shortening and oroclinal bending, and mid-Cretaceous rifting (Cunningham et al., 1996; Owen et al., 1999; Rippington, 2008;

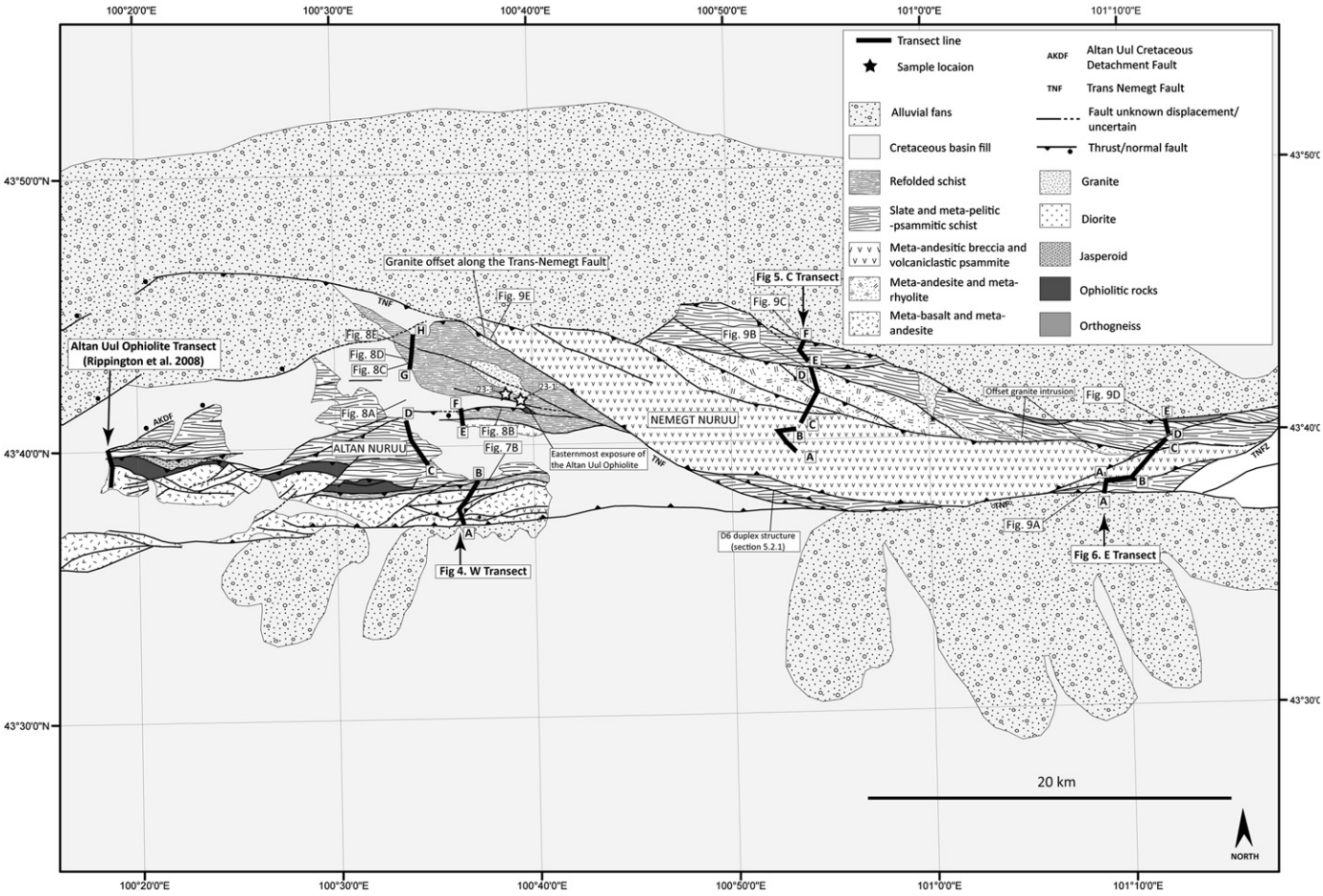

Fig. 2. A lithotectonic map of Nemegt and Altan Nuruu draped constructed from detailed visual interpretation of GoogleEarth satellite images. The main rock types and major structures discussed in the text are shown and the extensive Quaternary alluvial fans which flank Nemegt and Altan Nuruu to the south and north can be seen. The locations of the transects shown in Figs. 4–6 and the field photographs in Figs. 7–8 are marked. Black stars mark the locations of the samples taken for Ar–Ar analysis.