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Zircon U–Pb and molybdenite Re–Os geochronology, and whole-rock geochemistry of the Hashitu molybdenum deposit and host granitoids, Inner Mongolia, NE China

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ABSTRACT

The Hashitu deposit is a newly-discovered Mo deposit in the southern part of the Great Hinggan Range, NE China. Molybdenum mineralization occurs as quartz-sulfide veins within the Hashitu granite-porphyry composite pluton. The sulfide assemblage in the veins is dominated by molybdenite, with minor amounts of galena, sphalerite, chalcopyrite, pyrite and marcasite. The associated gangue minerals are quartz, fluorite, calcite, sericite, chlorite and epidote. Whole-rock chemical compositions show that the Hashitu granites belong to the A2-type. The U–Pb ages of zircons from the Hashitu granite and porphyry units are 147 ± 1 Ma and 143 ± 2 Ma, respectively. The Re–Os isochron age of molybdenites from the deposit is 150 ± 4 Ma. The molybdenite Re–Os model ages vary from 144 to 150 Ma, with a weighted mean of 147 ± 1 Ma. The results show that the ages of zircon crystallization and Mo mineralization are similar, mostly within analytical uncertainties, and that the host granite pluton is one of many late-Jurassic plutons in the Great Hinggan Range. The formation of the late-Jurassic granitic plutons in this region coincides with the subduction of the Pacific plate beneath the North China block which took place ~2000 km to the east at the time. The occurrence of abundant late-Jurassic granitoids with compositions similar to the Hashitu pluton in the Great Hinggan Range is a positive sign for more discoveries of Mo deposits in this region.

1. Introduction

The Mesozoic metallogenic province in eastern China hosts some of the largest molybdenum, tungsten, tin, antimony and bismuth deposits in the world (Mao et al., 2011). In northeastern China, the Great Hinggan Range, or the Da Hinggan Mountains Range, is an important polymetallic metallogenic belt hosting different types of hydrothermal deposits (Liu et al., 2001, 2012; Mao et al., 2003, 2005; Wu et al., 2011a,b; Zhou et al., 2012; Zhai et al., 2013; Zeng et al., 2013). More than ten large- and medium-sized Cu–Mo–Fe–Sn–Pb–Zn–Ag polymetallic deposits have been discovered in this belt to date. These include skarn, porphyry, and epithermal ore deposits that are spatially and temporally associated with the Mesozoic felsic magmatism in the region (Zhao and Zhang, 1997; Mao et al., 2003, 2005; Wang et al., 2006; Zhai et al., 2013). The associated Mesozoic igneous rocks are referred to as the Great Hinggan Mesozoic Igneous Province (Sengör and Natal'in, 1996). The genetic relationships between mineralization and magmatism in the region in the Mesozoic have been studied by many researchers (Mao et al., 2003, 2005; Zhang et al., 2009; Zeng et al., 2010, 2011). Mao et al. (2011) presented a synthesis of geology and tectonic settings of the Mesozoic ore deposits in northern China.

The Hashitu deposit is a newly-discovered Mo deposit in the southern part of the Great Hinggan Range, NE China. The exploration work in this area began in 1959 and the Inner Mongolia Geological Bureau finished the 1:100 million scale geological mapping in 1960. During 1984–1987, the Inner Mongolia Geological Survey Team carried out a 1:50,000 scale geological mapping, which summarized magmatic events in the Hashitu and adjacent areas. Since 2007, the Chifeng Geological Institute began mineral exploration work in the Hashitu area and discovered the No. I and II ore bodies. They also determined that the ore bodies were hosted in the granite and granite porphyry (Lu et al., 2009). Because this deposit was discovered in recent years, few studies have been conducted to

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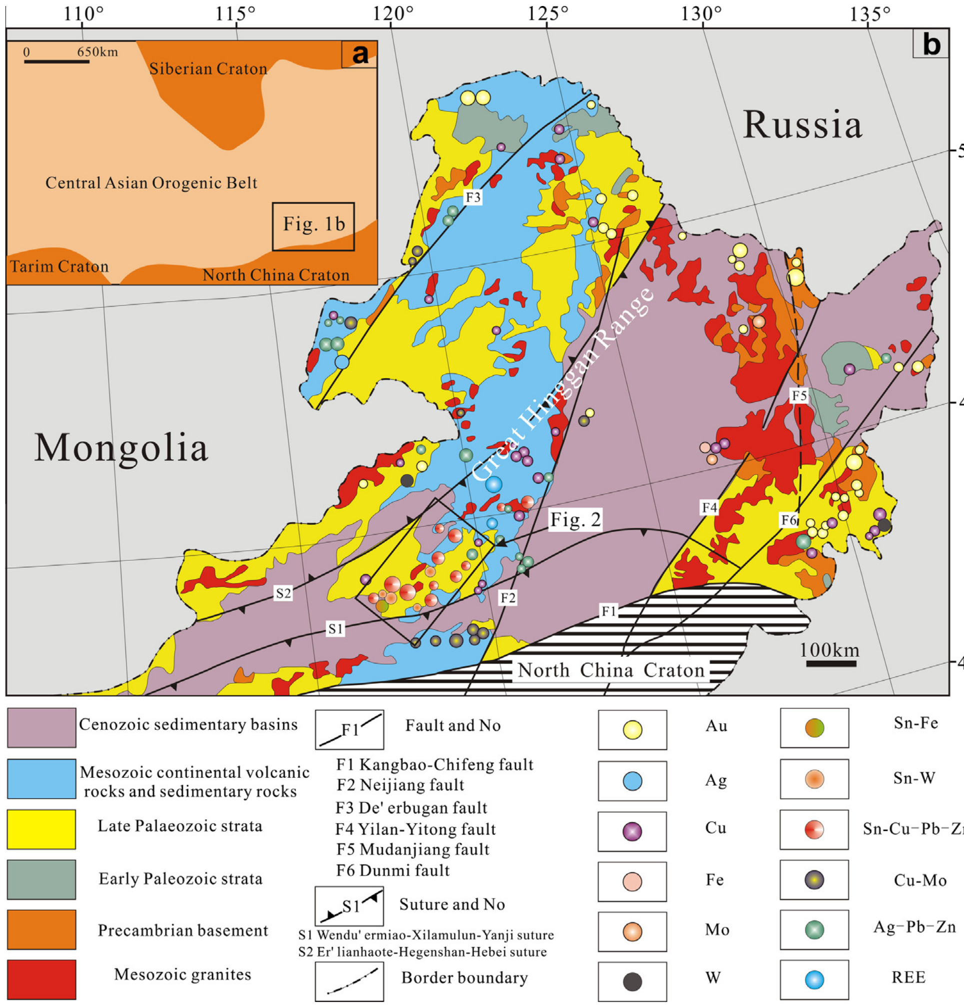

Fig. 1. (a) Simplified geological map showing location of the Central Asian Orogenic Belt (Modified from Jahn, 2004). (b) Geological sketch map and hydrothermal deposit distribution of central Inner Mongolia and adjacent areas (Modified from Qi et al., 2005).

understand the geochemistry and geochronology of host granitic intrusions and their relationships with the Mo mineralization, which are important to understanding the ore genesis and geodynamic setting of Mo mineralization. The lack of accurate geochronological data has increased the difficulties in establishing a genetic model for the Hashitu Mo deposit and regional metallogenesis in the southern part of the Great Hinggan Range.

In this contribution, we describe the geology of the Hashitu Mo deposit, with particular focus on the temporal relationships, petrology, mineralogy, geochemistry and geochronology of the host intrusions and Mo mineralization. At the same time, we present entirely new whole-rock geochemical data, U–Pb geochronological data regarding magmatic zircon and the Re–Os isochron age of hydrothermal molybdenite from the Hashitu Mo deposit to constrain the relationships between Mo mineralization, the intrusion system and regional geodynamic evolution. This work also contributes to a better understanding of ore genesis, the metallogenic system and geodynamic development in the southern part of the Great Hinggan Range, NE China.

2. Geological settings

2.1. Regional geology

The Great Hinggan Range is located at the eastern section of the Central Asian Orogenic Belt (CAOB) between the Siberian Craton and the North China Craton (NCC) (Fig. 1a). The CAOB is a giant accretionary orogen, which is bounded by the Siberian, the Tarim, and the North China cratons (Fig. 1a), and is believed to be the world's largest site of juvenile crust formation in the Phanerozoic (Jahn, 2004; Jahn et al., 2009; Shi et al., 2010). This region experienced a long and complex geodynamic evolution and the regional tectonic and magmatic activity can be summarized as follows: (1) the formation of the Archean–Paleoproterozoic basement lithotectonic units (Sengör and Natal'in, 1996); (2) the Neoproterozoic to Paleozoic crustal accretion related to the subduction of the Paleo-Asian Ocean (Jia et al., 2004; Windley et al., 2007; Jian et al., 2009); (3) the subsequent uplifting of the orogenic belt in response to the collision between the North China–Mongolian bock and the Siberian craton in the Early Mesozoic (Buslov et al., 2004; Wu et al., 2004); (4) the post-orogenic extension since the Late Jurassic (Li et al., 2007; Guo et al., 2010); and (5) the subduction of the Pacific Ocean since the Late Cretaceous (Taira, 2001; Guo et al., 2010). The Sr–Nd–Pb isotope mapping results of the CAOB suggest that during the Mesozoic period the crustal growth mainly occurred around the collisional sutures and/or along the major lithosphere-scale faults (Guo et al., 2010). Recent studies suggested that crustal evolution in the CAOB involved both juvenile material and abundant reworking of older crust with varying proportions throughout its accretionary history (Kröner et al., 2013). Meanwhile, the Central Asian Orogenic Belt (CAOB) is also considered to be one of the world's most important regions for Cu, Fe, Sn, Ag, Au and