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Late Paleozoic peperites in West Junggar, China, and how they constrain regional tectonic and palaeoenvironmental setting

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ABSTRACT

Late Paleozoic peperites have been identified for the first time at the bottom of Tailegula Formation in West Junggar, China. This finding is significant for the reconstruction of Late Paleozoic evolution in the Junggar region. The peperites form successions up to 500 m thick interbedded with basaltic lava and sedimentary rocks. Four types of peperites are described and interpreted as resulting from basaltic lava bulldozed into wet, unconsolidated sediments at their basal contacts. Zircon LA-ICP-MS U–Pb dating of a tuff lens enclosed by lava showed that the peperites formed in the Late Devonian (ca. 364 Ma). The peperite-bearing units probably formed at a water depth of less than 3 km and are generally undeformed, occurring in continuous stratigraphic sections distributed regionally over a distance of 100 km on either side of the Darbut and Baijiantan ophiolitic belts, in contrast to the highly deformed slices of ophiolite. They demonstrate that the Darbut and Baijiantan ophiolitic belts should not be interpreted as significant plate boundaries and represent the underlying ocean crust uplifted along tectonic lineaments within a continuous shallow remnant ocean basin. The peperites formed during the spreading phase of the remnant ocean basin and represent the final stages of creation of oceanic crust.

1. Introduction

The Central Asian Orogenic Belt (CAOB), also called Altaid Tectonic Collage (Sengör et al., 1993; Sengör and Natalin, 1996; Yakubchuk, 2004), is one of the largest accretionary orogens in the world and extends about 5000 km from the Urals in the west to the Sikhote-Alin' in the Russian Far East, where it is truncated by Mesozoic Pacific subduction–accretion systems, separating the Siberian craton from the Tarim and North China cratons (Fig. 1a). The belt was formed by Neoproterozoic–Paleozoic successive amalgamation of allochthonous oceanic and pericratonic terranes, island arcs and possibly microcontinents (Coleman, 1989; Jahn et al., 2000, 2004; Windley et al., 2007; Xiao et al., 2008; Wang et al., 2010). West Junggar region is bounded by the Altai orogen to the north, the Tianshan orogen to the south, the Kazakhstan plate to the west and the Junggar basin to the east (Fig. 1b). It is located at the east end of the Kazakhstan orocline (Windley et al., 2007; Xiao et al., 2010), and is considered to be part of the triple junction where the Siberian, Tarim and Kazakhstan plates are sutured (e.g. Feng et al., 1989). Therefore, West Junggar is a key area for the reconstruction of the evolutionary history of the CAOB. The Late Palaeozoic is a critical period of oceanic closure and continental amalgamation, yet there is so far no consensus on the orogenic processes and tectonic evolution during this period (e.g., de Jong et al., 2008; Xiao et al., 2008; Han et al., 2010; Wang et al., 2010).

In the Darbut region of West Junggar, the occurrence of common ophiolitic rocks (Zhang et al., 1993) and younger A-type granites with strongly positive ε_{Nd} (Chen and Arakawa, 2005) indicates that the region was underlain by oceanic crust in the Late Paleozoic. In this paper, we describe new discoveries about thick and widespread peperites formed by interaction of basaltic lava and sediments in this region.

Peperites are generated by magma intruding and mingling with wet unconsolidated or poorly consolidated sediment and exhibit a range of complex textures (Kokelaar et al., 1985; Busby-Spera and White, 1987; Doyle, 2000; White et al., 2000; Skilling et al., 2002). Generally, peperites are distributed along the contacts of intrusions of any composition, lava flows or hot volcaniclastic deposits with sediments. Interaction of magma with wet sediment or sediment-laden water is common and peperites can occur in any setting where magma and wet unconsolidated sediment come into contact. Most peperites have formed in submarine sedimentary sequences (Brooks et al., 1982; Busby-Spera and White, 1987; Goto and McPhie, 1996; Doyle, 2000; Kano, 2002) or lacustrine successions (Cas et al., 2001; Erkül et al., 2006), into which magma was intruded or flowed over as lava (Beresford and Cas, 2001; Dadd and Van Wagoner, 2002; Waichel et al.,

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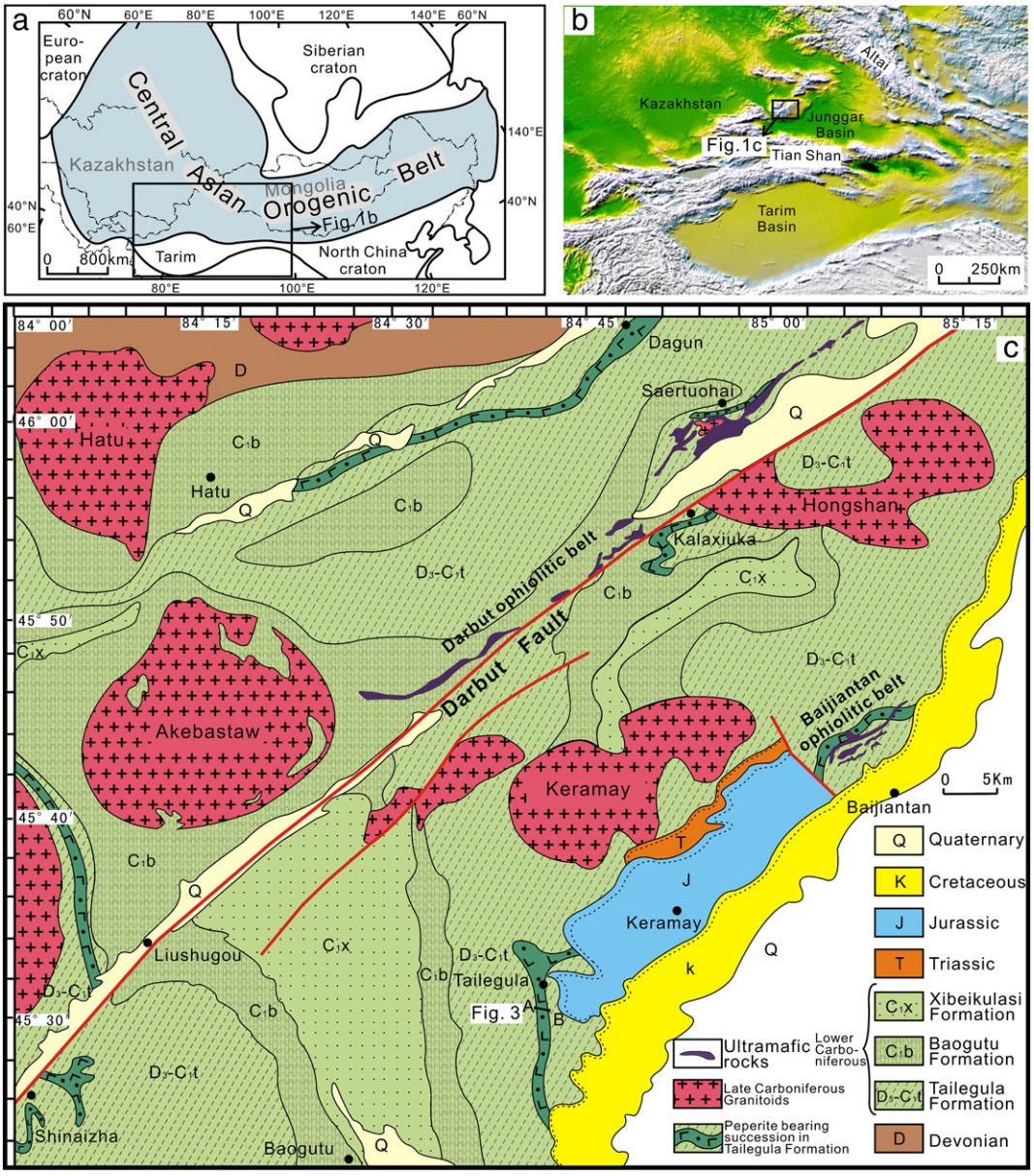

Fig. 1. (a) Simplified sketch map of Central Asian Orogenic Belts (modified after Sengör et al., 1993; Jahn et al., 2000). (b) Digital elevation model of North Xinjiang area. (c) Geologic map of West Junggar (modified after the geologic map of 1:200,000 produced by XBGMR, 1966).

2007; Jordan et al., 2008). Peperites provide information on the mechanisms by which magma interacts with wet sediment. The occurrence of peperites indicates approximate contemporaneity of magmatism and sedimentation, therefore, the study of peperites is also important for relative chronology. Busby-Spera and White (1987) distinguished two major groups of peperites based on the dominant shape of the juvenile clasts: blocky and fluidal. They also demonstrated that the textures of peperites are mainly controlled by the granularity of the host sediment. Other factors such as confining pressure, magma composition and viscosity also play a role (Doyle, 2000; Dadd and Van Wagoner, 2002; Squire and McPhie, 2002; Martin and Németh, 2007).

The purpose of this paper is first to describe the range of textural types of peperite and to determine their absolute age (using zircon LA-ICP-MS U–Pb dating) and style of emplacement. We then use the undeformed stratigraphic setting of the peperites as an important marker unit to constrain the Late Paleozoic tectonic and palaeoenvironmental setting in West Junggar. Finally, we consider the potential role of peperites as an important component of oceanic crust in marginal oceanic basins.

2. Geological setting and local stratigraphy

The principal rock assemblages in West Junggar include Palaeozoic ophiolitic belts and Lower Carboniferous sedimentary formations, both of which are intruded by sub-circular Late Carboniferous granitoid plutons (Fig. 1c).

Two subvertical belts of ophiolitic rocks, principally serpentinite, outcrop in West Junggar: the Darbut ophiolitic belt and the Baijiantan ophiolitic belt (Fig. 1c). There is no evidence that the belts were obducted onto continental crust and both belts are interpreted as part of the crust of a paleo-ocean basin that existed during the Late Paleozoic (Xu et al., 2006). The precise ages of the two ophiolitic belts are still under determination. The Darbut ophiolitic belt is distributed along the Darbut Fault, striking NW. A Sm–Nd isochron age of 395 ± 12 Ma (Zhang and Huang, 1992) and a LA-ICP-MS zircon U–Pb age of 391 ± 6 Ma (Gu et al., 2009) were obtained from the gabbroic rocks of this ophiolite. However, a LA-ICP-MS zircon U–Pb age of 302 ± 2 Ma from leucocratic gabbros was also reported (Liu et al.,