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Middle Paleozoic mafic magmatism and ocean plate stratigraphy of the South Tianshan, Kyrgyzstan

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ABSTRACT

The tectonic history of the Kyrgyz South Tianshan in the western Central Asian Orogenic Belt (CAOB) remains controversial, first of all, due to the limited amount of geochemical and isotope data. Our paper presents the first results of a detailed geochemical study (major and trace elements, Sr, Nd and Pb isotopes) of Middle Paleozoic mafic volcanic and subvolcanic rocks of the Ferghana and Atbashi–Kokshaal accretionary belts of the South Tianshan orogen in Kyrgyzstan, which formed during the evolution of the Turkestan Ocean. A special focus is given to the relation between magmatic rocks and sedimentary units of marine origin, chert, siliceous shale/mudstone, volcanogenic–carbonate clastics, seamount carbonates, and turbidites, which we consider as elements of Ocean Plate Stratigraphy (OPS). The age range of marine sediments is Late Silurian to Early Carboniferous, but the age of the most volcanic rocks associated with fossil-bearing OPS sediments is Devonian. The magmatic rocks have geochemical affinity to oceanic island basalts (OIB-type) and, to a lesser extent, mid-oceanic ridge (MORB-type) basalts associated with hemipelagic siliceous mudstone and pelagic chert. The rocks with OIB-type affinity are associated with chert, siliceous shale and carbonaceous clastics and carbonates. They are enriched in TiO_2, LREE ($La/Sm_n = 1.9$), and Nb ($Zr/Nb_{av.} = 10$), have differentiated HREE ($Gd/Yb_n = 2.0$), medium to low εNd (~5.7) and are characterized by clear Nb positive anomalies in normalized multi-element plots ($Nb/Th_{pm} = 1.3$, $Nb/La_{pm} = 1.1$). The OIBs formed by relatively low degrees of melting (<5%) of mantle sources in the garnet stability field and erupted in an oceanic island setting. The MORB-type samples associated with siliceous mudstone and chert are less enriched in incompatible elements, possess flat REE and multi-element pattern, and show higher εNd values (~9.1); they were probably produced by high-degree melting of spinel lherzolite and/or harzburgite and erupted in a mid-oceanic ridge setting. The geological, lithological and geochronological data suggest that the OPS units with dominantly OIB-type basalts formed at one or several seamount chains of the Turkestan Ocean, which were accreted to the Kazakhstan continent, and thus contribute to our understanding of the Paleozoic tectonic evolution of the western CAOB during the Serpukhovian–Bashkirian.

1. Introduction

The Central Asian Orogenic Belt (CAOB) is one of the largest orogens on Earth, and its evolution has been a matter of considerable debate, particularly in terms of presence/absence of microcontinents, relative contributions of juvenile and recycled crustal material and domination of Pacific-type orogens in its structure (e.g., Windley et al., 2007; Xiao et al., 2010; Safonova et al., 2011b; Kröner et al., 2014; Safonova and Maruyama, 2014). The more than 800 Ma history of the CAOB began in the Neoproterozoic by the opening of the Paleo-Asian Ocean and was followed by multiple collisions between the Siberian, Kazakhstan, Tarim, and North China blocks from the Devonian to the Late Permian (Fig. 1) (e.g., Buslov et al., 2001; Dobretsov et al., 2003; Safonova, 2009; Biske and Seltmann, 2010; Xiao et al., 2013). The CAOB consists of several distinct branches of which the Tianshan is one of the major belts extending across the territories of Kazakhstan, Uzbekistan, Tajikistan, Kyrgyzstan and northwestern China (e.g., Biske, 1996; Bakirov and Maksumova, 2001; Windley et al., 2007; Burtman, 2008; Xiao and Kusky, 2009; Wang et al., 2011; Xiao et al., 2013). The Kyrgyz Tianshan is part of the Tianshan orogen, that formed by the closure of the Turkestan Ocean (or South Tianshan or Paleo-Tianshan), a branch of the Paleo-Asian Ocean, and subsequent collision of the Kazakhstan

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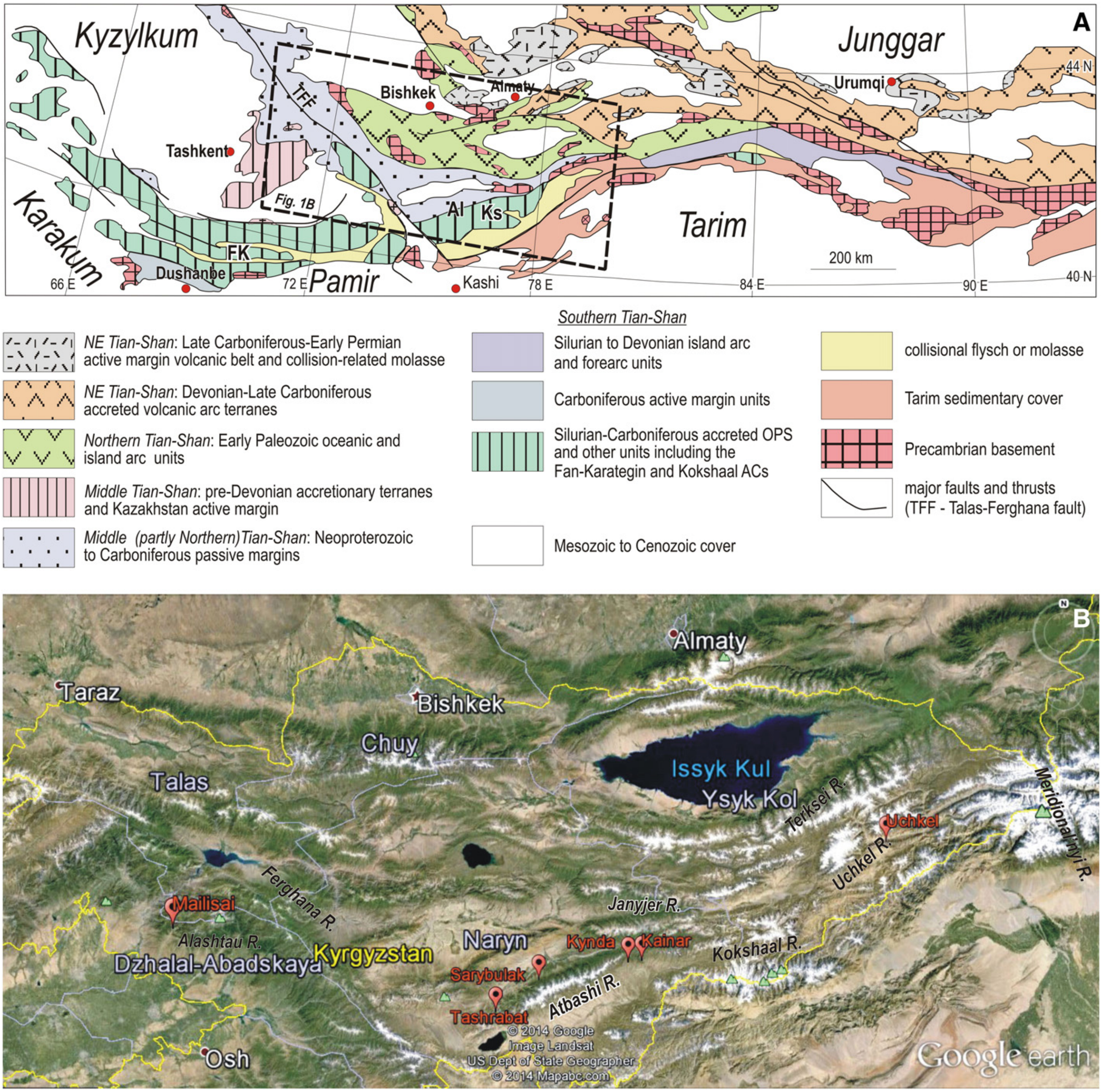

Fig. 1. Tectonic scheme of the Tianshan (A; modified from Biske and Seltmann, 2010) with a GoogleMap picture showing sites of sampling (B). AI = Atbashi–Inylchek suture; FK = Fan–Karategin; Ks = Kokshaal; OPS = Ocean Plate Stratigraphy; R. = Range.

continent and Tarim Craton during the Pennsylvanian–Early Permian (e.g., Seliverstov and Ges', 2001; Charvet et al., 2007; Biske and Seltmann, 2010; Burtman, 2010; Han et al., 2011; Wang et al., 2011; Alexeiev, et al., 2015). In Kyrgyzstan, the South Tianshan orogen includes the EW-trending Alashtau, Atbashi, Kokshaal and several smaller ranges, which are oriented almost perpendicularly to the SW-striking Meridional'nyi Range in the east (Fig. 1B). The Kyrgyz Tianshan is traditionally considered to consist of the South, Middle and North Tianshan zones (e.g., Biske, 1991; Biske and Tabuns, 1996; Bakirov and Maksumova, 2001; Seliverstov and Ges', 2001; Burtman, 2008; Simonov et al., 2008; Biske et al., 2013). The South Tianshan orogen is a fold-and-thrust belt bound by the Tarim craton in the south and an oceanic suture in the north, possibly reflecting the Turkestan Ocean sensu stricto (Burtman and Porshnyakov, 1974). However, in spite of extensive geological studies of the last 30 years the tectonic history of the Kyrgyz South Tienshan in the western CAOB remains controversial.

Three major groups of Paleozoic to Mesozoic mafic magmatic complexes occur in the South Tianshan orogen: oceanic and supra-subduction ophiolites and intra-continental basaltic fields (e.g., Biske, 1991; Biske and Tabuns, 1991; Jiang et al., 2001; Ma et al., 2006; Simonov et al., 2008; Zhu et al., 2008; Wang et al., 2011; Biske et al., 2013; Simonov et al., 2015; Fig. 1A). Oceanic ophiolite complexes of the Kyrgyz Tianshan include mafic volcanic and subvolcanic rocks associated with sedimentary rocks of shallow to deep marine origin. The Middle Paleozoic mafic rocks of the South Tianshan orogen, which probably formed in an oceanic setting, have been discussed before (e.g., Kurenkov, 1983; Khristov et al., 1986; Biske and Tabuns, 1996; Kurenkov et al., 2002; Dong et al., 2006; Long et al., 2006; Alekseev