Paleozoic geodynamics and architecture of the Mongolian Altai Zone

Turbold Sukhbaatar1,2, Ondrej Lexa1, Karel Schulmann2, Carmen Aguilar2,3, Pavla Štípská2, Jean Wong4, Yingde Jiang5, Jitka Míková2, and Dingyi Zhao4

1 Charles University, Geology, Institute of Petrology and Structural Geology, Prague, Czechia
2 Czech Geological Survey, Klárov 3, 11821 Prague, Czech Republic
3 Departament de Mineralogia, Petrologia i Geologia Aplicada, Facultat de Ciències de la Terra, Universitat de Barcelona, Zona Universitària de Pedralbes, 08028 Barcelona, Spain
4 Department of Earth Sciences, The University of Hong Kong, Pokfulam Road, Hong Kong, China
5 State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China

The Mongolian Altai Zone is a part of the extensive Cambrian–Ordovician accretionary system located at the junction of the Siberian craton to the north and Tarim and North China cratons to the south. It extends approximately 2,000 km from Russia to Mongolia and represents one of the critical elements for reconstructing the early Paleozoic geodynamics of the Central Asian Orogenic Belt (CAOB). The studied section comprises a succession of deformed low- and high-grade metasedimentary rocks characterised by dominant terrigenous components mixed with volcanogenic material. The detrital zircons analysis revealed two separate groups a) more mature siliciclastic sediments (mostly sandstones) with maximum depositional age of Cambrian–Ordovician (ca. 463–489 Ma; zircon U-Pb) and b) more juvenile greywacke type sediments with Ordovician–Silurian (ca. 438–446 Ma; zircon U-Pb) maximum depositional age. U-Pb ages of detrital zircons show Cambrian-Ordovician (εHf(t) values –24.8 to +16.0) and Late Archean to Neoproterozoic source (εHf(t) values –35.5 to +10.4) and are interpreted as derived from the Ikh Mongol continental arc and the Baydrag continent. The greywackes, in addition, contain Silurian detrital zircons, with εHf(t) values from −0.5 to +13, suggesting syn-depositional contribution of juvenile material from a nearby magmatic arc. Both types of sediments are affected by Devonian (ca. 369–382 Ma; zircon U-Pb) metamorphism and magmatism granites, as well as strongly reworked during the Permian (ca. 271–296; zircon U-Pb) under various metamorphic conditions. Late Devonian granitoids associated with felsic migmatites, and their zircon εHf(t) values from −9.5 to +13.5, indicate extensive melting of the sedimentary pile. A Permian high-temperature metamorphism is associated with granodiorite intrusions (εHf(t) values from −22.0 to +12.6) that contain Devonian zircon xenocrysts, suggesting melting of a Devonian source. The tectonic evolution of the Mongolian Altai Zone can be discretized in four events from which the first two were related to early Paleozoic metamorphic and magmatic evolution. The third one is associated with crustal-scale detachment that exhumed the early Permian migmatite-migmatite core complex in the south. The whole edifice was later affected by significant Permian
Triassic horizontal N-S shortening leading to juxtaposition of contrasting crustal levels thereby forming “apparent” terrane structure of the Mongolian Altai Zone. The whole edifice is interpreted as a Cambrian to Silurian fore-arc, affected by Devonian syn-extensional deep crustal melting. In addition, the Permian anatectic zone is interpreted as a deep part of an inverted continental rift.