Composition of the clastic rocks of Northern Kyrgyz Tien Shan

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The structure of the Tien Shan belongs to the southern part of the Central Asian Orogenic Belt, formed as a result of the evolution and closure of the Paleo-Asian Ocean (Zonenshain et al., 1990). The Kyrgyz part of the Tien Shan is traditionally divided into three tectonic segments, which are called the Northern, Middle and Southern Tien Shan. The Northern and Middle Tien Shan are separated by the Terskei-Karatau fault ("Nikolaev Line"). The Kyrgyz Northern Tien Shan is a part of the Kokchetav-North Tianshan active margin, which is represented by tectonically combined fragments of Precambrian crust with Early Paleozoic ophiolites, island-arc and metamorphic complexes combined in the Early Paleozoic and significantly processed island-arc and syn-collisional granitoid magmatism in the Ordovician-Silurian period. Clastic rocks were selected along the Kyrgyz range of the Northern Tien Shan at the Belogorka and Ala-Archa sites.

Petrographic description of clastic rocks has shown that they are characterized by a wide range of grain sizes from fine- to coarse-grained, the degree of roundness of fragments from angular to subangular, the sorting of clastic material is medium and low. Mono- and polycrystalline quartz, plagioclase, potassium feldspar, muscovite, biotite, fragments of volcanic, metamorphic and sedimentary rocks were identified in the thin-sections. Rutile, apatite and zircon are present as accessory minerals. Secondary changes are represented by the processes of chloritization and sericitization. According to the classification (Shutov, 1967), the rocks are feldspar-quartz and quartz-feldspar greywackes.

According to the concentrations of the major oxides, sandstones are characterized by an increased content of SiO_2 (72.9-84.0 wt. %) at TiO_2 values (0.3–0.5 wt. %), Al_2O_3 (5.2–10.6 wt. %), Fe_2O_3 (3.0–4.1 wt. %) and MgO (0.8–1.8 wt. %). For a detailed study of the composition of sandstones and rock characteristics in the source area, the petrochemical modules of Yudovich were calculated (Yudovich, Ketris, 2000). The studied sandstones are characterized mainly by low and medium values of AM (0.07–0.20), TM (0.03–0.06), HM (0.14–0.39), MM (0.09–0.57), increased values of FM (0.09–0.57) and high values of FM (0.60-2.35), which indicates increased ferruginosity and a predominantly weak degree of chemical weathering of the initial rocks. There

is a direct relationship between FM and TM, which indicates that sandstones are sedimentary rocks of the first cycle, i.e. petrogenic. According to the classification diagrams of F. J. Pettijohn most of the sandstones are greywackes. Negative trends on TiO_2, Al_2O_3, Fe_2O_3, and MgO relative to SiO_2 are observed on Harker variational binary diagrams. Similar patterns are typical for igneous rocks of the island-arc origin. According to the values of the petrochemical indexes CIA and ICV, it was found that the studied sandstones are characterized by an immature nature and a low content of clay minerals. This confirms the conclusion that sandstones belong to immature sediments of the first sedimentation cycle.

The rare earth element spectra normalized by chondrite and multielement spectra normalized by primitive mantle are similar to similarly normalized spectra of PAAS (Post-Archean Australian Shales). The spectra of the distribution of the concentration of rare earth elements (REE) showed a predominantly negative Eu anomaly (Eu/Eu* = 0.62–0.89), close to that for PAAS (Taylor, McLennan, 1985). According to the values of the ratios ($(La/Yb)_n$ = 7.27–12.31), it can be assumed that the protoliths for most of the samples were intermediate and acidic rocks. On the multielement spectra, negative Ta-Nb anomalies are distinguished for all samples: $(Nb/La)_{pm}$ = 0.26-0.49, $(Nb/Th)_{pm}$ = 0.11-0.19. There is also a negative anomaly in Ti: $(Ti/Y)_{pm}$ = 0.15-0.82. Such characteristics are typical for island-arc igneous rocks.

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Zonenshain, L.P., Kuzmin, M.I., Natapov, L.M., 1990. Geology of the USSR: a plate tectonic synthesis. Geodynamic Monograph. American Geophysical Union, Washington, Geodynamics Series 21, 242 p.

Shutov, V.D., 1967. Classification of sandstones. Litologia i Poleznye Iskopaemye 5, 86-102. (in Russian)

Yudovich Y.E., Ketris M.P. Fundamentals of lithochemistry. St. Petersburg: Nauka, 2000. 479 p. (in Russian)

Taylor S.R., McLennan S.M., 1985. The Continental Crust: Its Evolution and Composition. Blackwell, London, 312 p.