Detrital zircon U-Pb ages, Lu-Hf isotopes and whole-rock geochemical and isotope data from greywacke sandstones of eastern Kazakhstan

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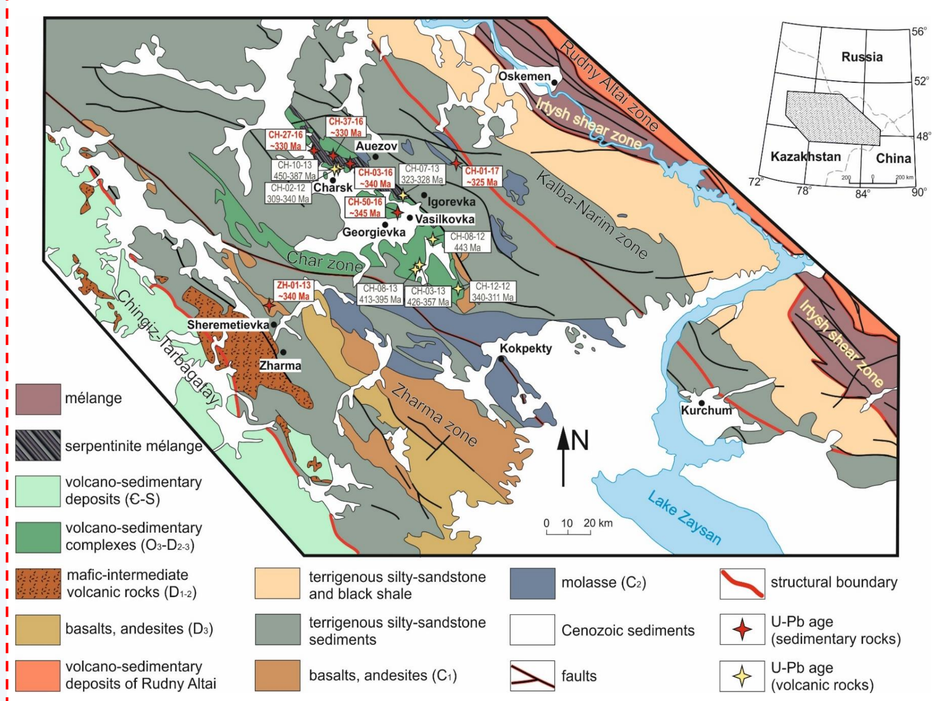
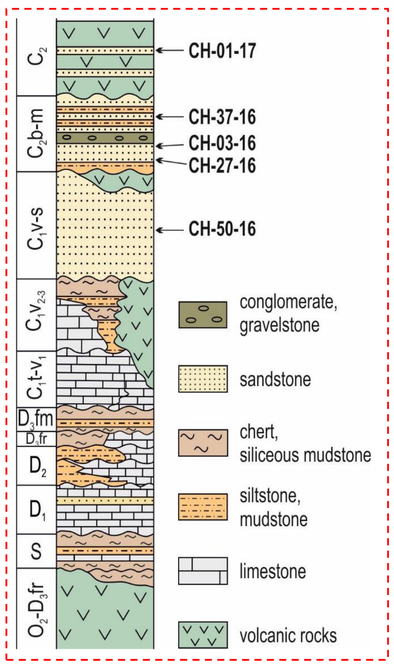
Geological outline



Geological scheme of eastern Kazakhstan (modified from Khromykh et al., 2020).

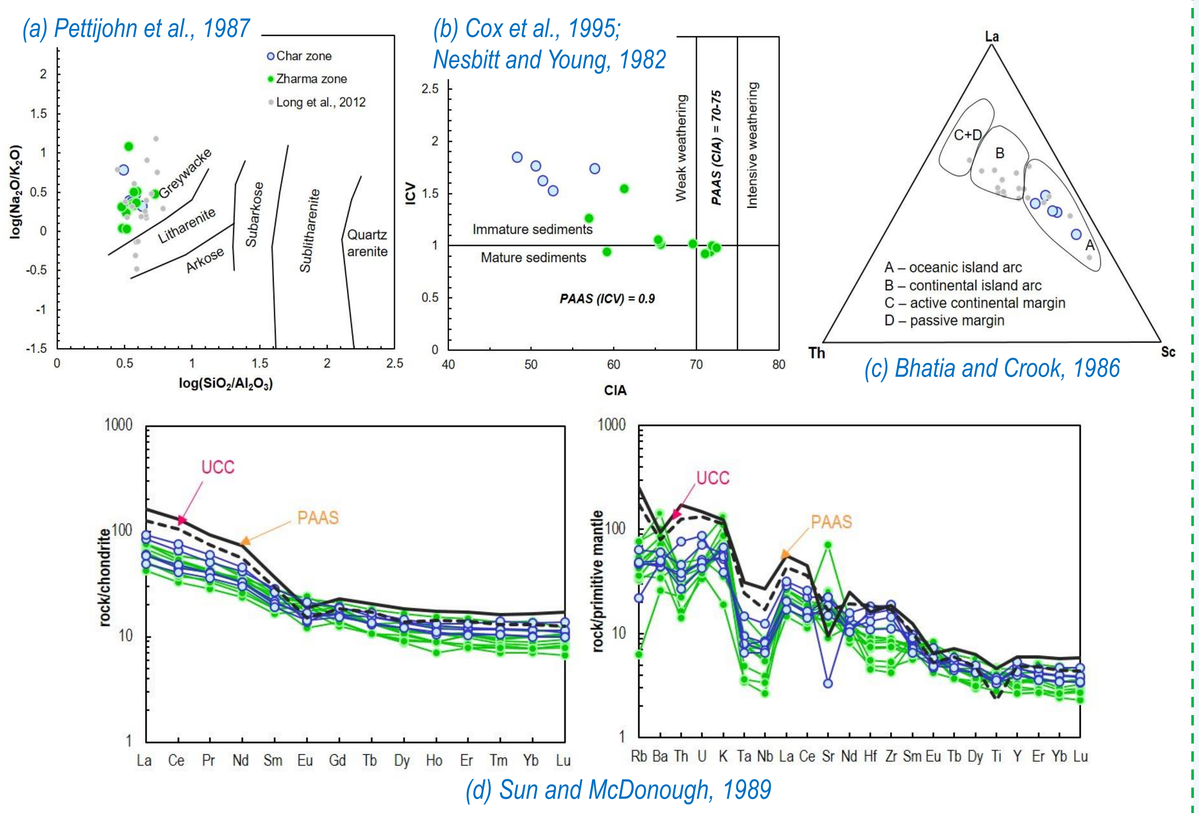


Stratigraphic column (modified from Safonova et al., 2012).

The Char and Zharma zones are located in the western Central Asian Orogenic Belt, in the eastern Kazakhstan. The Zharma-Saur terrane extends over a distance more than 450 km from eastern Kazakhstan to NW China (West Junggar). It represents a junction zone between the Caledonian Chingiz-Tarbagatai foldbelt and the Hercynian Ob`-Zaizan foldbelt, including the Char zone. The Char zone represents an axis of the Ob`-Zaisan belt extending over a distance of more than 320 km at a width of only 7–10 km and consists of several thrust tectonic sheets dipping to the north–east at high angles separated by thrust and strike-slip fault planes *(Polyanskiy et al. 1979; Ermolov et al. 1981; Buslov et al. 2001, 2004)*. It includes Devonian to Carboniferous igneous and sedimentary rocks of Ocean Plate Stratigraphy (OPS), arc-related igneous rocks and fore-arc and continental sediments *(Safonova et al., 2012, 2018)*.

The sandstones under the study are associated with late Devonian and early Carboniferous volcanic rocks of supra-subduction (intra-oceanic arc) geochemical affinities, cherts, siliceous mudstones and siltstones, conglomerates and gravelstones.

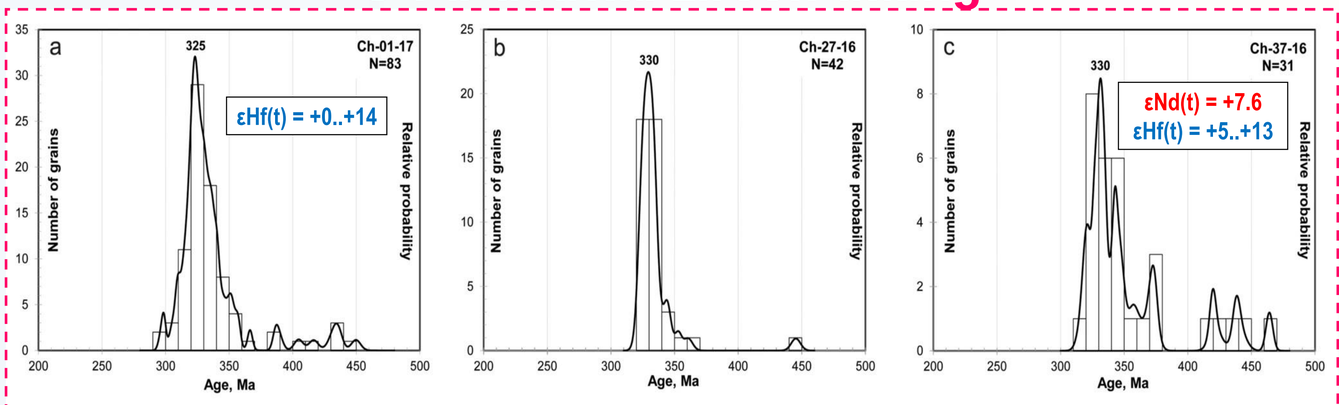
Whole-rock geochemistry



Classification and discrimination diagrams:
(a) – the Char and Zharma samples plot in the field of **greywacke**;
(b) – the sandstones show low SiO_2/Al_2O_3 and medium Na_2O/K_2O ratios suggesting **insignificant post-depositional alteration.** CIA = 48-59 → a low-degree of alteration caused by chemical weathering; ICV = 0.93-1.85 → suggest an immature source, i.e., their protoliths formed in an intra-oceanic or continental arc setting, at an active margin.
(c) – the rocks plot in the **inta-oceanic island arc field.**

All those characteristics suggest that the igneous protoliths of the Char and Zharma sandstones formed in an intra-oceanic arc setting.

U-Pb detrital zircon dating



Ch-01-17: age interval is 449-299 Ma, major peak – 325 Ma

Char zone

Ch-50-16: age interval is 370-320 Ma, major peak – 345 Ma

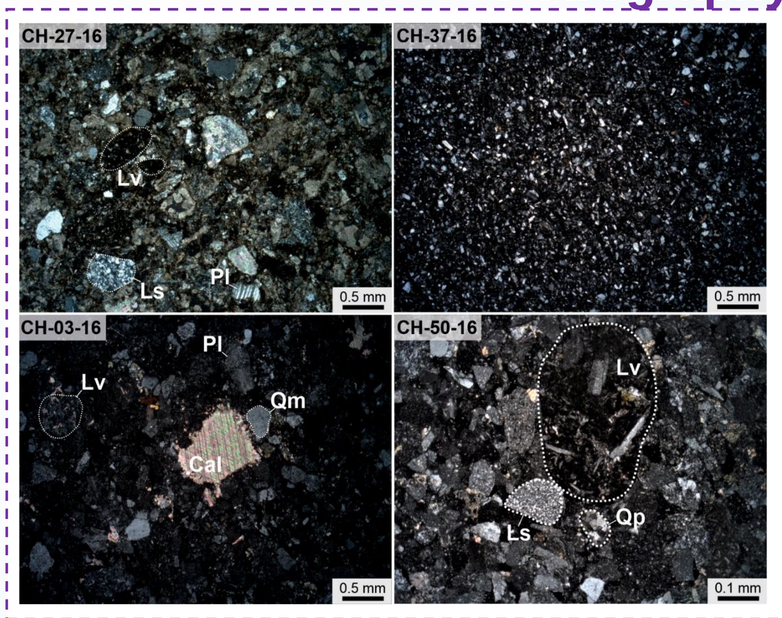
Ch-27-16: age interval is 445-320 Ma, major peak – 330 Ma

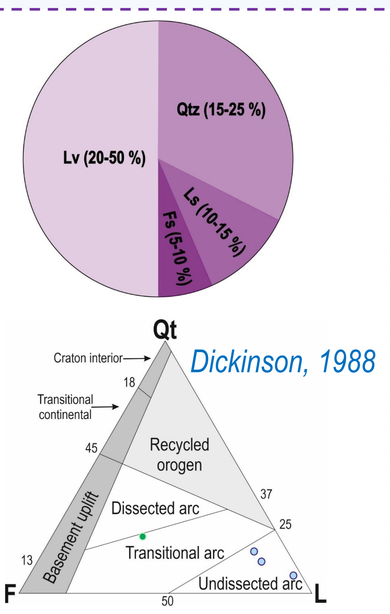
Ch-37-16: age interval is 464-317 Ma, major peak – 330 Ma

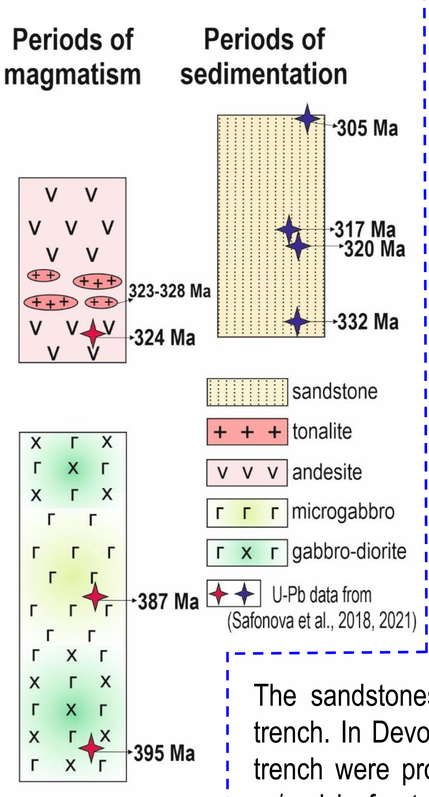
Ch-03-16: age interval is 370-320 Ma, major peak – 340 Ma

Zharma zone — **Zh-1-13:** age interval is 445-301 Ma, major peak – 340 Ma

Petrography







Tectonic implications

The Char zone represents a suture–shear zone hosting not only oceanic ophiolites and OPS volcanic and sedimentary units (*Safonova et al., 2012*), but also igneous rocks of suprasubduction origin (*Safonova et al., 2018*).

The petrography-based QFL systematics of (*Dickinson, 1988*) indicates that the Char and Zharma samples were derived from undissected and transitional arc respectively.

The U–Pb zircon ages of the Char igneous rocks also show two main stages of magmatism: Devonian and early Carboniferous (*Safonova et al., 2018*).

The geochemical and isotope compositions of the sandstones suggest that their igneous protoliths formed in an intra-oceanic arc setting.

The sandstones were deposited either in a fore-arc basin or/and in a trench. In Devonian–early Carboniferous time, the fore-arc basin and the trench were probably located in front of one or more intra-oceanic arcs or/and in front of an Andean-type continental arc of the western Paleo-Asian Ocean.

CONCLUSIONS

1. The sandstones of the Char and Zharma zones occur in association volcanic rocks with supra-subduction geochemical characteristics, pelagic (cherts), hemipelagic sediments (siliceous mudstones/siltstones), conglomerates and gravelstones.
2. The sandstones are greywacke, lithic arenite and litharenite; their geochemical features resemble those of supra-subduction igneous rocks.
3. The unimodal distribution curves of the U-Pb ages, geochemical and isotopic data (Hf-in-zircon and whole-rock Nd) suggest the deposition at the Pacific-type convergent margin associated with one or more Devonian to early Carboniferous intra-oceanic arcs once existed in the Paleo-Asian Ocean.