Strontium isotope composition of Mesozoic ammonoid shells [Reply to] comments on "New aragonite $^{87}Sr/^{86}Sr$ records of Mesozoic ammonoids and approach to the problem of N, O, C and Sr isotope cycles in the evolution of the Earth" [*Sedimentary Geology*, 364 (2018): 1–13]

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Key words: ammonoid ethological groups, brachiopods, Sr, O, and C isotopes, palaeotemperatures.

Abstract. The stimulating reviewer's remarks on the systematics of the Jurassic ammonoids which were isotopically investigated by us have substantially improved our paper, which provided data from the Triassic, Jurassic and Cretaceous.

I am a specialist on Permian–Triassic ammonoids, bio- and chemostratigrapy mainly of the Russian Far East, therefore all remarks on Jurassic fossils from the Russian Platform, received from M.A. Rogov (2018), an expert on Jurassic ammonoids of this area are very important for me.

Almost all the material for the discussed article, with exception of the ammonoids from Madagascar, was collected solely by its authors. The T]riassic aragonite ammonoids from Arctic Siberia were collected by Y.D. Zakharov, the Jurassic brachiopod and mollusc fossils from the Russian Platform and Switzerland by A.M. Popov and Y.D. Zakharov, the Cretaceous mollusc fossils from England, Argentina, British Columbia, California and the Russian Platform were collected by Y.D. Zakharov, Y. Shigeta, I.A. Michailova and E.Y. Baraboshkin, and the recent *Nautilus pompilius* was caught in the Philippines area by Y. Shigeta.

Only a few fossils from the Russian Platform (A.M. Popov's Jurassic ammonoids and brachiopods) were collected many years ago, during the Khar'kov's expedition, organized by Prof. Y.I. Kats in 1972. Thanks to the stimulating reviewer's remarks I have learned that the Sr isotope ratio ($^{87}Sr/^{86}Sr = 0.707429$) obtained from one of the samples (55/1) of A.M. Popov's collection should be dated as Upper Tithonian, and not Upper Callovian, as was consider earlier (Zakharov *et al*., 2018).

I agree also that it would be better to identify the Early Toarcian representatives of the genus Hildaites from the famous locality of Mount Teysachaux (Etter *et al.*, 2014) rather in open nomenclature (*Hildaites* sp.), because their shells are flattened out. However, these aragonite-preserved mollusc shells (up to 92% aragonite) are an available object for isotope investigation.

M.A. Rogov writes in his review that "the upper Berriasian of Dorset is represented by the non-marine Purbeckian facies". However, I do not entirely consider so, because I have collected a couple small, but well-preserved brachiopod (= "bivalve") shells from Oyster Bed of the upper Berriasian Durlston Formation (Gale *et al.*, 2009), allowing the calculation of

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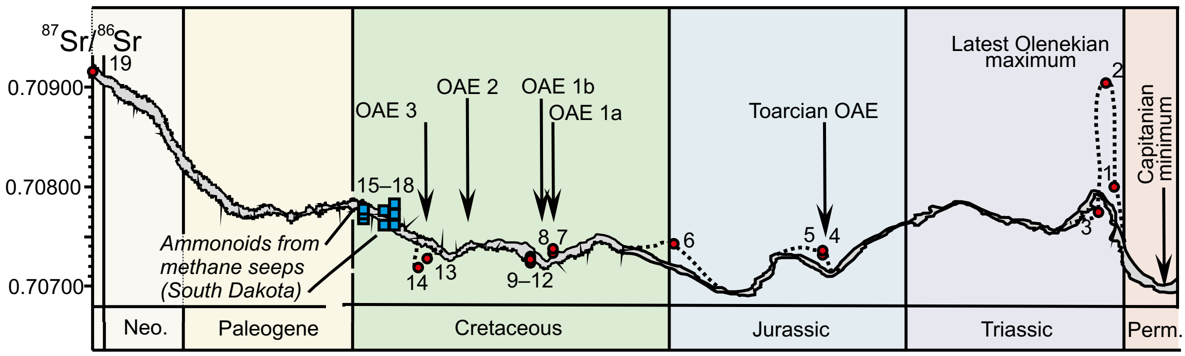

Fig. 1. Seawater Sr isotope curve
(variant of McArthur *et al.* (2012), corrected on the basis of data obtained from aragonite-preserved cephalopod shells)

1. *Hedenstroemia hedenstroemi* (Keyserling) (Lower Olenekian); **2.** *Boreomeekoceras keyserlingi* (Mojsisovics) (Upper Olenekian); **3.** *Arctohungarites* sp. (mid Anisian); **4.** *Hildaites* sp. (Lower Toarcian); **5.** *Harpoceras falciferum* (J. Sowerby) (Lower Toarcian); **6.** *Kachpurites cheremkhensis* Mitta, Mikhailova et Sumin (Upper Volgian); **7.** *Deshayesites volgensis* Sasonova, sample 45–96 (Lower Aptian); **8.** *Deshayesites volgensis* Sasonova, sample 50–96 (Lower Aptian); **9.** *Desmoceras* sp. (Lower Albian); **10.** *Cleoniceras* sp. (Lower Albian); **11.** *Douvilleiceras* sp. (Lower Albian); **12.** *Eotetragonites umbilicostatus* Collignon (Lower Albian); **13.** *Pseudoschloenbachia umbulazi* (Baily) (Upper Santonian); **14.** *Submortoniceras* sp. (Lower Campanian); **15–18.** Cochran *et al.* (2003) data (*Baculites*, *Eutrephoceras*, *Jelezkytes*, *Sphenodiscus*; Upper Cretaceous, including Maastrichtian); **19.** Recent *Nautilus pompilius* Linne. Abbreviations: Perm. – Permian; Neo. – Neogene

palaeotemperatures of 26.3–28.7°C on the basis of isotope data (δ^{18}O values are –3.81 and –3.30‰, respectively, δ^{13}C = 0.27–0.46‰; Zakharov *et al.*, 2013, table 1).

The reviewer also considers that the differences within the Sr isotope values of different ammonoids from Madagascar could be caused by variations in the geological age of the studied samples (but not the secretion of the investigated shells in habitats from shallow to deeper zones of the water column). I do not consider so, because I believe that the investigated ammonoids were collected from a single layer belonging the Cleoniceras besairiei or Douvilleiceras inaequinodum zones (Zakharov *et al.*, 2011, 2016). On the basis of the stable isotope data, obtained from the Cretaceous of Madagascar and the Upper Palaeozoic–Mesozoic of other regions two large ethological group can be recognised in mid-aged and adult ammonoids: (1) animals requiring cool conditions, apparently preferring mainly mesopelagic conditions (*e.g.*, Zakharov *et al.*, 2001, 2006a, b, 2011, 2013, 2014, 2016, 2017a, b, 2018; Stevens *et al.*, 2015), and (2) thermophilic dwellers, prefering, on the contrary, only epipelagic conditions (*e.g.*, Zakharov *et al.*, 2004, 2005, 2006a, b, 2016; Lécuyer, Bucher, 2006; Landman *et al*., 2012; Lukeneder, 2015; Moriya, 2015).

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