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GEOLOGY

First Results of the Zircon Fission-Track Dating of Mesozoic Flysch Sediments in the South Anyui Suture (Western Chukotka, Northeast Asia)

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The South Anyi Suture (SAS) is considered a collisional structure that formed at the site of the eponymous ocean as a result of the Early Cretaceous collision between Eurasia and the Chukotka microcontinent [2, 3, 11]. A research team from the Geological Institute of the Russian Academy of Sciences headed by S.D. Sokolov revealed that the SAS nappe comprises back-arc and oceanic formations of the Alazeya–Oloi island arc and South Anyui ocean, respectively [3] (Fig. 1). The autochthon is composed of carbonate–terrigenous rock complexes of the Anyi–Chukotka fold system (passive margin of the Chukotka microcontinent). The youngest age of folding is constrained by the pre-Albian regional unconformity [3]. However, timing of the completion of sedimentary process in marine basin in the Eurasia (SAS)–North American continent collision zone remains debatable. Terrigenous sediments in this basin lack organic fossils in the major part of the SAS zone. They are mapped as Upper Triassic, Upper Jurassic, or Lower Cretaceous formations based on the lithological similarity with paleontologically substantiated sequences located west and east of the study area. Therefore, we sampled barren Mesozoic rocks of the SAS zone to obtain detrital zircon for the fission-track dating. The present work is the first attempt to apply this method for dating terrigenous formations in the SAS zone in order to specify the time of flysch sequence completion in the South Anyui paleobasin and reconstruct sedimentation settings.

Geology and lithology. The study area is characterized by a thrust–fold structure of northern vergence [3] (Fig. 1, cross section). Dominant are tectonic sheets composed of Triassic and Upper Mesozoic flysch [1] (Fig. 2). Samples 9947 and 9947/1 were collected from sandstones within the distal thin-rhythmic flysch exposed at upper reaches of the Uyamkanda River. Their Late Jurassic age is based on lithological similarity with the paleontologically substantiated flysch sequence located west of the study section containing *Buchia* remains. Sample 9986 (sandstone) was taken from the proximal flysch at lower reaches of the Uyamkanda River (Figs. 1, 2). Based on geological survey data, the proximal flysch is an Upper Triassic formation. Our observations suggest that the sampled sections represent elements of a tectonically distorted single regressive marine sedimentary succession (Fig. 2a).

The composition of the detrital sandstone fraction is given in Table 1. The proportions of rock-forming minerals indicate that sandstone of Sample 9947/1 is closer to the Upper Jurassic field, whereas sandstones of samples 9986 and 9947 gravitate toward the Lower Cretaceous field (Fig. 2b).

Results of fission-track dating. In fission-track dating, the track preservation depends first of all on temperature. The track system in zircons is usually closed at 215–240°C [6]. The age of the youngest zircon population is close to that of sedimentation, if the time lag between zircon crystallization and burial in sediments as a result of magmatic activity is a few million years [6, 9].

The zircon age was determined in the Fission-Track Dating Laboratory of the Union College, United States. Zircons were dated using the external detector method [12]. The samples were irradiated simultaneously with the Fish Canyon Tuff, Buluk Tuff, and uranium-doped

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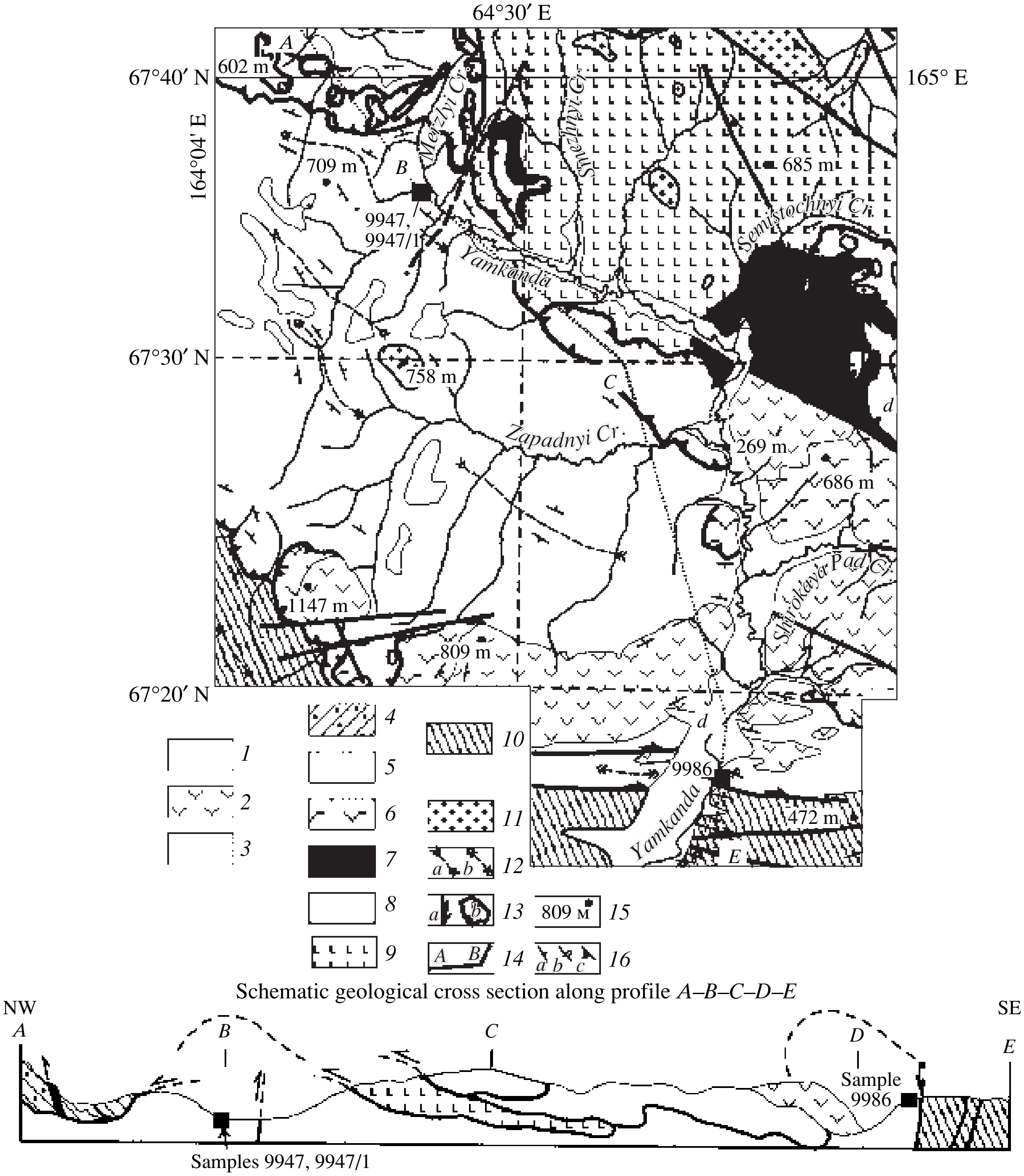

Fig. 1. Geological map of the Uyamkanda River basin (based on geological survey data of the Anyui GGGP, Bilibino) showing sampling points and geostructural cross section along profile *A–B–C–D*. Overlying complexes: (*1*) Quaternary alluvial sediments, (*2*) Albian–Upper Cretaceous continental volcanics (neoautochthon-2), (*3*) Hauterivian–Barremian terrigenous sediments (neoautochthon-1); allochthonous complexes of the South Anyui suture: (*4*) terrigenous melange, (*5*) Upper Jurassic–Lower Cretaceous volcanomictic turbidites and olistostromes, (*6*) Upper Jurassic island-arc volcanics, (*7*) plutonic ophiolite rocks, (*8*) basalts, cherts, and dikes of undefined age, (*9*) Bathonian–Callovian basalts, cherts, and dikes; (*10*) Upper Triassic arkosic turbidites (autochthon); (*11*) granitoids; (*12*) synform (*a*) and antiform (*b*) axes; (*13*) (*a*) strike-slip and (*b*) thrusts faults; (*14*) geological profile; (*15*) altitude marks; (*16*) altitude of (*a*) normal and (*b*) overturned bedding and (*c*) cleavage.

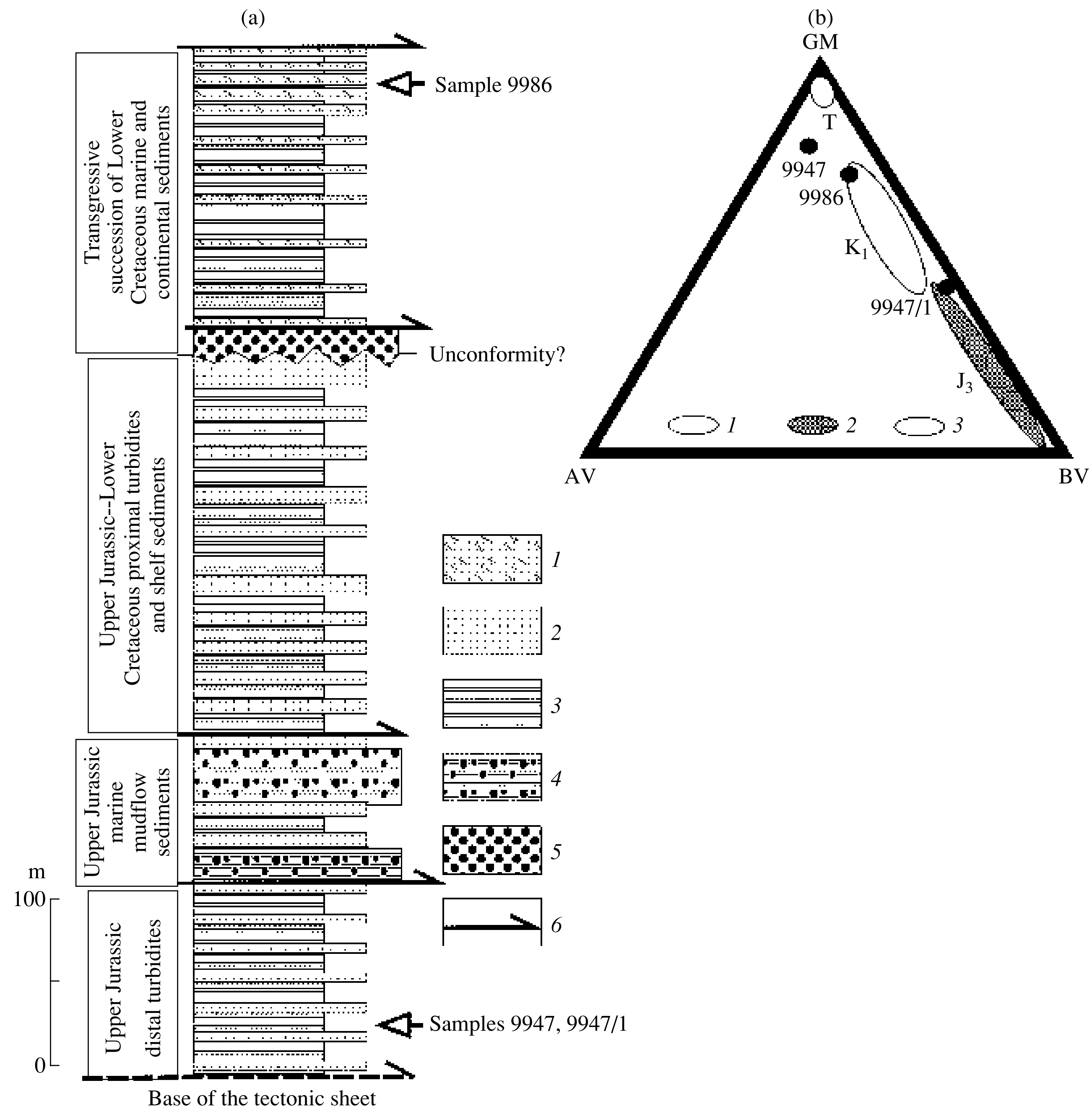

Fig. 2. (a) Schematic stratigraphic section of the allochthonous sheet of Upper Jurassic–Lower Cretaceous tuffaceous–terrigenous sediments in the Uyamkanda River basin; (*1*) highly bioturbated sandstone, (*2*) sandstone, (*3*) siltstone and mudstone argillite, (*4*) olistotrome unit, (*5*) conglomerate and breccia, (*6*) tectonic dislocation conformal to bedding. (b) Metamorphic rocks–acid volcanics–basic volcanics classification diagram [4] with sandstone data points. Preliminary composition fields of different-age terrigenous rocks were obtained using data on 22 reliably dated samples. Composition fields: (*1*) Upper Triassic sandstones from the Anyui–Chukotka belt, (*2*) Upper Jurassic and (*3*) Lower Creatceous sandstones from the South Anyui suture. Fragments: (AV) acid volcanics; (GM) granite gneiss, metasedimentary, and quartzite-type rocks; (BV) basic volcanics.

glass standards at the Oregon State Nuclear Reactor [7]. In total, 38 to 50 zircon grains were dated for each sample (Table 2).

Sandstones contain two zircon populations (Table 1, Fig. 3a). The grain age–uranium content plot compiled for dated samples lack isolated clusters and significant deviation from the linear dependence (Fig. 3). Overheated zircon grains usually form a separate cluster deviating from the linear dependence [8]. Hence, zircons in the examined samples were not subjected to

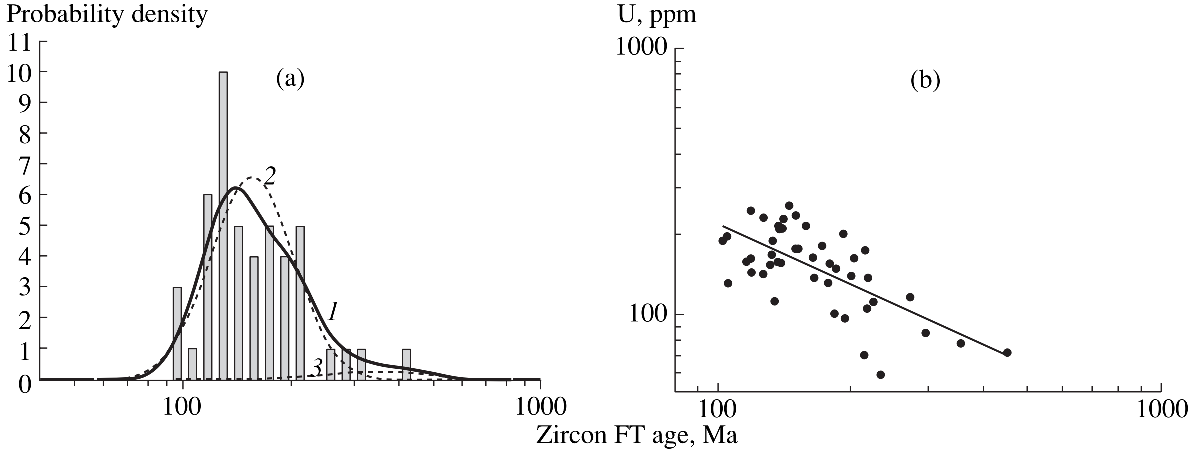

Fig. 3. (a) Example of the fission-track age distribution of detrital zircon grains and (b) its dependence on the uranium content in sandstone from the South Anyui suture (Sample 9947). (*1*) Observed; zircons of (*2*) older and (*3*) younger populations.

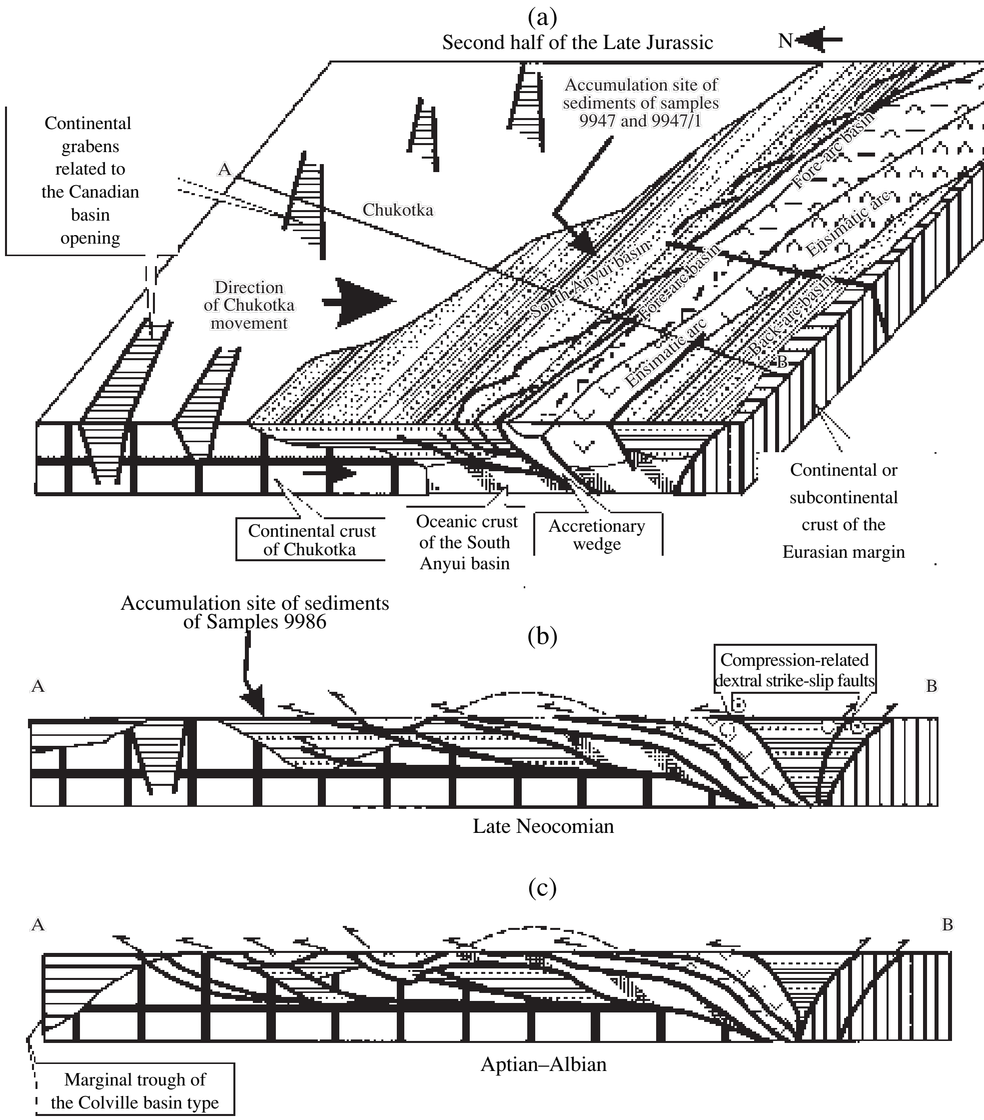

Fig. 4. Preliminary paleotectonic reconstruction for the (a) Late Jurassic, (b) Neocomian, and (c) Aptian–Albian development stages of the South Anyui sedimentation basin.

Table 1. Composition of detrital components in sandstones from the South Anyui suture

Component	Number of grains in thin section		
	Sample 9986	Sample 9947	Sample 9947/1
Quartz	60	30	36
Acid plagioclase (<No. 20)	16	4	none
Intermediate Na–Ca plagioclase (No. 20–45)	none	4	10
Microcline	none	none	16
Undifferentiated feldspar	14	26	16
Microperthite intergrowths	24	none	none
Acid volcanics	6	6	»
Unaltered basic volcanics	none	2	»
Albitized basalt	12	2	10
Pelitic tuffite	28	10	14
Granite gneiss	26	32	4
Quartzite	none	8	none
Shale	″	none	4
Micaceous shale	4	2	none
Total	190	126	110

Table 2. Fission-track age of detrital zircons from sandstones of the South Anyui suture

Sample no.	Lithology	Number of dated grains	Age of zircon populations, Ma	
			P_1	P_2
9986	Proximal turbidites	50	131.1 ± 7.5 (88.5%)	344.5 ± 70.3 (11.5%)
9947	Distal turbidites	47	155.4 ± 9.0 (94.4%)	354.2 ± 90.3 (5.6%)
9947/1	The same	38	149.6 ± 10.2 (79.5%)	293.8 ± 59.9 (20.5%)

Note: (P_1, P_2) Zircon populations calculated using the BINOMFIT v. 1.8 program [5].

partial annealing, and their age corresponds to the provenance cooling time. Thus, the ages of young zircon populations estimated at 155.4 ± 7.5, 149.6 ± 10.2, and 131.7 ± 7.5 Ma (samples 9947, 9947/1, and 9986, respectively) characterize the lower age limit of sedimentation.

The lithological composition of sandstones indicate that the sedimentation was accompanied by synchronous volcanic eruptions in the adjacent area. Thus, the youngest zircon population may be coeval to the host sediment.

Conclusions. Late Jurassic (samples 9947 and 9947/1) and Early Cretaceous (sample 9986) fission-track ages were first obtained for detrital zircons from terrigenous sequences including those previously referred to the Late Triassic. Datings of the youngest zircons suggest that flysch sediments continued to accumulate in the closing South Anyui paleobasin up to the end of the Hauterivian (131 Ma) during fold-and-thrust dislocations (Figs. 4a, 4b) that accompanied the collision of Eurasia with the North American continent. In the post-Hauterivian time, marine sedimentation shifted to the Vil'kitskii–North Chukotka and Colville shelf basins, where the thickness of Albian–Cenozoic marine sediments reaches 3 km or more [10].

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