https://doi.org/10.15407/dopovidi2020.12.048
UDK 550.4 (477); 551.21:551.24

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Stages in evolution of Earth's crust recorded by the Huliaipole block of the West Azov area (4.0-2.0 Ga)

Presented by Academician of the NAS of Ukraine O.M. Ponomarenko

The U-Pb age of zircon populations from metadacite of the Huliaipole Suite was determined using the LA-ICP-MS method as 3085-2850 and 3700-3360 Ma. In addition, two crystals of zircon were discovered with an age of more than 3800 Ma. According to geological and geochronological data, the Huliaipole Block, 30 × 50 km in size, is composed of rocks and relicts of the Hadean, Archean, and Palaeoproterozoic eons. The oldest nucleus of the Azov Domain was probably formed from 3.97 to 3.3 Ga ago. In the Mesoarchean (3.2-3.0 Ga), it became a part of the Middle Dnieper-Azov-Kursk granite-greenstone terrane. Felsic and intermediate volcanics of the Huliaipole Suite could have formed due to the melting of the sialic crust, including rocks of the Hadean and Archean age, as a result of the underplating of basic melts during the formation of the Neoarchean to Paleoproterozoic rift structures..

Keywords: *West Azov, Huliaipole block, Hadean, Archean, Paleoproterozoic, Ukrainian Shield, U-Pb age.*

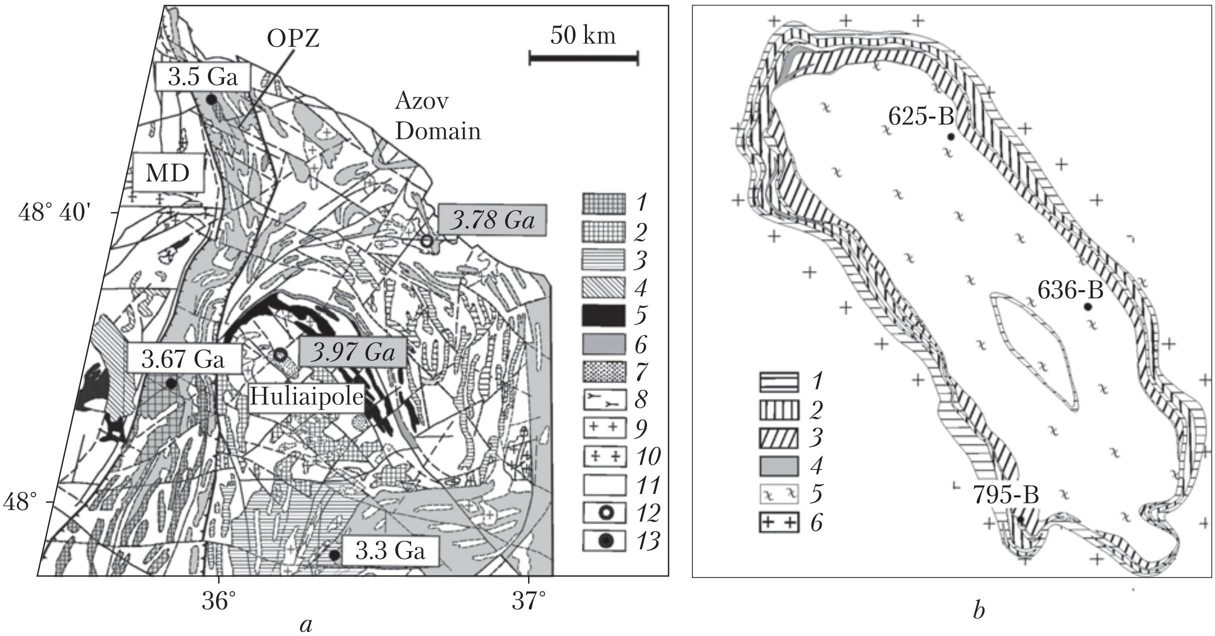
Introduction. In the Ukrainian Shield, rocks of the Earth's early crust were found in the Azov and Dniester-Bouh regions [1-3]. In the Dniester-Bouh region, they are highly metamorphosed and represented by enderbites and mafic crystalline schists with an age up to 3.8 Ga. A special feature of the Azov Domain is a relatively weak metamorphism of Archean rocks, not exceeding the epidote-amphibolite and amphibolite facies. Here, tonalites with ages of 3.67, 3.5, and 3.3 Ga have been identified. Metaterrigenous rocks in the Soroki greenstone structure (GS) and Neoarchean to Palaeoproterozoic troughs contain detrital zircon of Paleoarchean and Eoarchean ages from 3.3 to 3.8 Ga [4], which indicate the presence of yet undiscovered ancient rocks in the

Цитування: Artemenko G.V., Shumlyanskyy L.V., Wilde S.A., Whitehouse M.J., Bekker A.Yu. Stages in evolution of Earth's crust recorded by the Huliaipole block of the West Azov area (4.0-2.0 Ga). *Допов. Нац. акад. наук Укр.* 2020. № 12. С. 48—59. https://doi.org/10.15407/dopovidi2020.12.048

Azov Domain. Some researchers previously suggested that the most ancient granulite-gneissic complexes of the Azov and Dniester-Bouh domains, as well as the Voronezh Crystalline Massif, are fragments of one of the most ancient protocratons [2]. Author of work [5] suggested a model for the autonomous evolution of the "Early Archean cores" of the Azov and Dniester-Bouh domains, which is confirmed by new geological data.

Geological structure of the study area. The Azov Domain is a part of a larger Mesoarchean (3.2-3.0 Ga) craton, fragments of which are preserved in the eastern part of the Ukrainian Shield and as a block of the Kursk Magnetic Anomaly (KMA). In the Neoarchean-Palaeoproterozoic time, it was fragmented into several tectonic blocks: Vovcha, Remivka, Huliaipole, Bilotserkivka, and Saltych. The Huliaipole block is 30 × 50 km in size. To the west, north, and east, it is bordered by the Orekhiv-Pavlohrad structure, the Vovcha and Remivka blocks, respectively (Fig. 1, *a*). The Huliaipole and Remivka blocks are separated by the Hauchur fault of northwestern orientation, to which the Mesoarchean Kosivtsevo greenstone structure is confined. To the south, the Huliaipole Block is bordered by the Bilotserkivka Synclinorium and Korsak-Stulneve Anticlinorium. Analyzing the geological and structural position of greenstone belts in this area, which are characterized by a concentric shape and distinct confinement to faults, B.Z. Berzenin was the first to conclude that they formed on the Paleoarchean granulite-gneissic basement above the mantle plume [7]. The northern part of the Huliaipole Block is composed of the tonalite-trondhjemite-granodiorite (TTG) rock association, which contains remnants of greenstone structures, while the central and southern parts are almost completely composed of younger granitoids. In the central part of the Huliaipole Block, the Huliaipole syncline (3.5 × 9 km) of the NW orientation occurs [8]. Syncline limbs are steeply deeping to the center at an angle of 50-70°. According to geophysical data, the depth of the fold extent is estimated at 2.1-2.3 km. This structure is composed of volcano-sedimentary rocks of the Huliaipole Suite, about 1700 m thick, unconformably overlying the Archean TTG. The Huliaipole Suite is subdivided into three subsuites. The lower one (250 m thick) is composed of two-mica and andalusite-staurolite quartzites and schists; the middle one (450 m thick) consists of mainly ferruginous quartzites and metavolcanics of felsic and intermediate composition; the upper one (1000 m thick) is composed of biotite schists, often graphite-bearing, sometimes high-alumina quartzites and quartzite schists with flysch-like alternations. To a limited extent, meta-andesites and felsic metavolcanics are also found in the lower Huliaipole and upper Huliaipole subsuites [6]. The volcanics reach 70 m in thickness. From the margins to the center of the structure, there is a lateral replacement of ferruginous quartzites by metavolcanics. In the same direction, in the lower and upper subsuites, clay-rich facies are replaced by sandy ones. The U-Pb (TIMS) age of the multi-grain detrital zircon fractions from quartzites of the Lower Huliaipole Subsuite is 2.9 ± 0.1 Ga; the time of metamorphism of the rocks of the Huliaipole Suite is estimated at 2.14 Ga [9].

The Mesoarchean (3.2-3.0 Ga). The Kosivtseve and Haychur greenstone belts are composed of metamorphosed rocks of the jaspilite-komatiite-tholeiite association (the Kosivtseve unit), which is correlated with the Sura Suite of the Konka Series of the Middle Dnieper Domain [10]. Metamorphosed peridotite komatiites of the Kosivtsevo Greenstone Belt belong to the undepleted alumina type: $CaO/Al_2O_3 = 1.23$ and $Al_2O_3/TiO_2 = 11.61$. Ni content in the Kosivtseve Greenstone Belt peridotite komatiites reaches 841 ppm and Cr content is up to 2540 ppm. Amphibolites correspond to tholeiitic basalts. The metabasalts are characterized by a flat un-



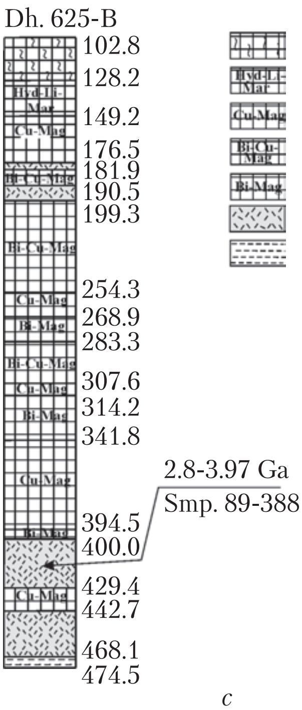


Fig. 1. *a*: Schematic geological map of the northern part of the West Azov area. MD — Middle-Dnieper domain, OPZ - Orekhiv-Pavlohrad zone. *1* — Novopavlivka unit; *2* — Novopavlivka Complex; *3* — West Azov Series; *4* — Auly Series; *5* — Greenstone belts; *6* — Central-Azov Series; *7* — Huliaipole Suite; *8* — alkaline intrusions; *9* — Paleoproterozoic K-Na granites; *10* — Archean K-Na granites; *11* — plagiomigmatites of the Shevchenko and Dnepropetrovsk complexes; *12* — dating points of tonalites; *13* — dating points of clastogenic zircons and xenogenic zircons in felsic metavolcanics.
b: Schematic geological map of the Huliaipole brachisyncline [6]. *1* — quartzites, metasandstones; *2* — andalusite-biotite-magnetite shales; *3* — magnetite, silicate-magnetite quartzites; *4* — magnetite-silicate quartzites; *5* — quartz-feldspar-biotite shales; *6* — amphibole-biotite plagiogranites.
c: Schematic column of drill-hole 625-B. *1* — weathering crust of barren quartzites; *2* — quartzites with hydromica-limonite-martite (Hyd-Li-Mar, iron-rich weathering crust); *3* — quartzites with cummingtonite-magnetite (Cu-Mag); *4* — quartzites with biotite-cummingtonite-magnetite (Bi-Cu-Mag); *5* — quartzites with biotite-magnetite (Bi-Mag); *6* — metamorphosed felsic volcanics; *7* — biotite schist

differentiated pattern of REE $(La/Yb)_N$ ~1.0. The REE concentrations in metabasalts of the Kosivtseve Greenstone Belt is 10 times chondrite content [11].

The TTG intrusions in the northern part of the Huliaipole Block are composed of sodium diorites and trondhjemites, and quartz diorites and tonalites of the potassium-sodium series. The U-Pb age of tonalites is 3.0 Ga, and that of trondhjemites is 2.92 Ga. According to Sm-Nd data, they were derived from a depleted (ε_{Nd}(T) = 0 to +2.6; T_{Nd}(DM) ~3.0 Ga) mantle and do not have "ancient crustal roots" [11]. Tonalites and trondhjemites are characterized by an average and very high degree of REE differentiation - $(La/Yb)_N$ = 7.7 and 133, respectively.

The Neoarchean-Palaeoproterozoic (2.8-2.0 Ga). The Neoarchean-Paleoproterozoic formations are represented by volcano-sedimentary rocks of the Huliaipole Suite and granitoids of the Dobropillya and Anadol complexes.

Granitoids of the Dobropillya Complex are confined to the Haychur and Dobropillya faults and to the southern margin of the Remivka Block. They are sharply discordant to the structure of the region and are represented by quartz diorites, plagioclase granites, and granodiorites of the potassium-sodium series, containing a large amount of pyroxenite, gneiss, and plagioclase granite xenoliths. According to the geological and geochemical data, the granitoids of the Dobropillya Complex were formed due to the melting of the older TTGs with a magma source characterized by T_{Nd}(DM) = 3,0-2,93 Ga [11]. The U-Pb isotope zircon age of granitoids of the Dobropillya Complex is 2040 Ma [12]. Inherited zircon has an age up to 3400 Ma.

The Anadol Complex. Small intrusions of two-feldspar granites are widespread in the Haychur area of the Ternuvate structure. In terms of chemical composition, they correspond to the subalkaline chemical group of felsic rocks of the potassium-sodium series. REE are highly differentiated with $(La/Yb)_N$ = 16.94, Yb_N = 8.47, and a prominent negative europium anomaly (Eu/Eu* = = 0.39). According to geochemical data, two-feldspar granites were derived from a crustal source. The U-Pb isotope monazite age of two-feldspar granites is 2190 Ma [13].

Felsic metavolcanics of the Huliaipole Suite. In the Huliaipole syncline, intermediate and felsic metavolcanics are closely associated with the Banded Iron Formation (BIF). Their age has not yet been studied. Zircon from meta-andesites and felsic metavolcanics of the Huliaipole Suite is very heterogeneous, which indicates their crustal derivation.

The Hadean-Paleoarchean (4.0-3.4 Ga). The presence of ancient crust in the Huliaipole Block is indicated by the large number of xenoliths in the granitoids of the Dobropillya Complex and the ubiquitous presence of xenocrystic zircon [14]. The Paleoarchean age of 3.3 Ga for xenocrystic zircon (multiple zircon grain method) was determined by [14] and of 3.4 Ga (SHRIMP U-Pb method) by [12]. A large amount of xenocrystic zircon was also found in metamorphosed andesites and dacites of the Huliaipole Suite. This zircon has been dated in this study using the LA-ICP-MS method. For the most ancient zircons, the age was also confirmed by secondary ion mass spectrometry (SIMS).

The sampled interval is composed of metadacites (sample 89-388, drill-hole 625-B, int. 424.4-429.4 meters) (Fig. 1, *b*, 1, *c*). The structure of the rock is blastoporphyritic with a lepidogranoblastic structure of the groundmass (Figs. 2, *a*, *b*, *c*). Phenocrysts are represented by albite. Phenocrysts are often granular and transformed into an aggregate of fine grains. Secondary minerals in phenocrysts are represented by biotite, sericite, muscovite, chlorite, carbonate, and magnetite. The bulk is composed (%): quartz + albite 75-77 %, biotite 20-22 %, chlorite — fractions of %, muscovite — single grains, magnetite — up to 1 %; apatite – 3-5 %, titanomorphite — fractions of %, zircon — single grains. Quartz and albite form aggregates of isometric grains 0.02 mm in size. Biotite and chlorite are unevenly distributed, forming clusters of elongated lenticular and irregular shape. Patchy segregations of magnetite, zircon, and titanomorphite are confined to biotite accumulations. An interesting feature of the rock is the high content of apatite (up to 5 %).

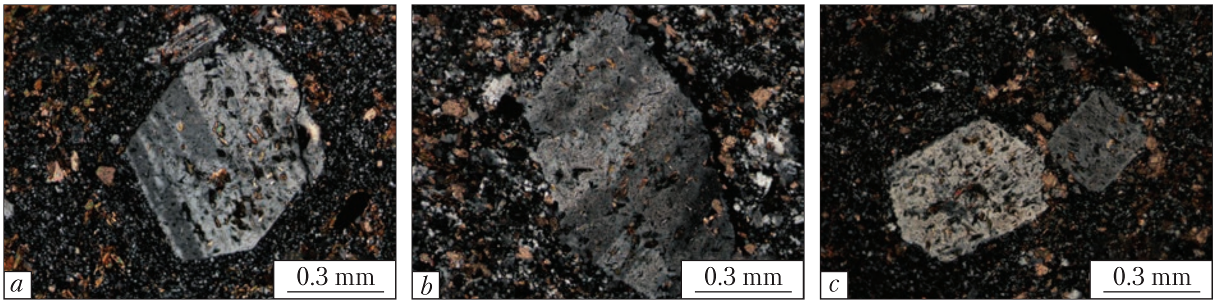


Fig. 2. Photomicrographs of thin sections of metadacites of the Huliaipole Suite, drill-hole 625-B: *a* – sample 89-384, depth 424.8 m; *b* – sample 89-385, depth 427.4 m; *c* – sample 89-386, depth 428.6 m. Images were taken using a polarizing microscope ECLIPSE LV100 POL. Crossed analyzers

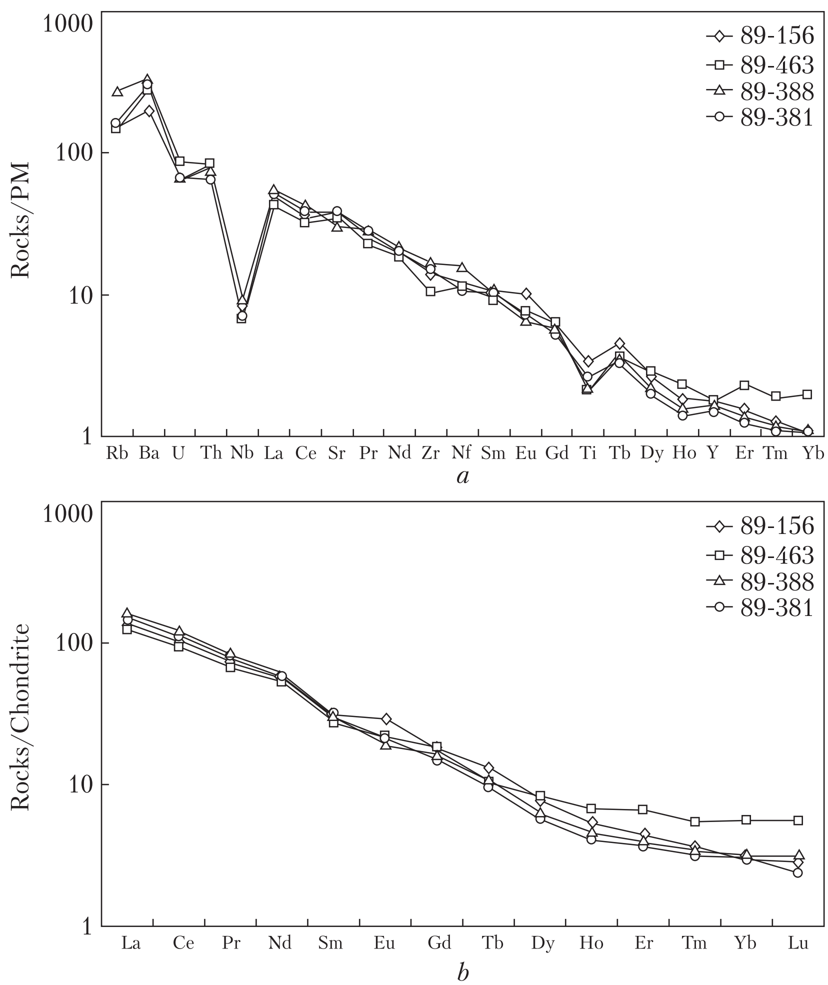


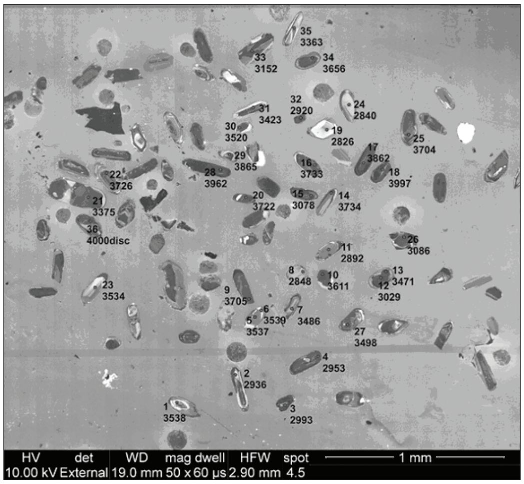
Fig. 3. Primitive mantle-normalized multi-element diagram for meta-andesites and metadacites of the Huliaipole Suite — *a*. Chondrite-normalized REE pattern for meta-andesites and metadacites of the Huliaipole Suite — *b*

Geochemistry. In terms of chemical composition, the metavolcanics of the Huliaipole Suite correspond to low-Mg (0.23-0.35) andesites and dacites of the normal series, potassium-sodium series (Table 1). On the SiO_2-K_2O diagram, they fall into the fields of high-K andesites and dacites of the calc-alkaline series. They have high content of Sr (743-816 ppm), Ba (1400-2116 ppm), and moderate content of Rb (97-103 ppm) (Table 1). The content of transition elements,

Table 1. **Chemical composition of metavolcanics of the Huliaipole Suite**

%	89-156	89-463	89-381	89-388	ppm	89-156	89-463	89-381	89-388
SiO_2	60.70	62.58	63.98	65.70	Ge	—	—	—	—
TiO_2	0.74	0.46	0.47	0.57	Y	8.19	8.17	7.0	7.5
Al_2O_3	14.60	13.74	13.36	13.93	Nb	6.49	4.82	5.0	6.7
Fe_2O_3	0.35	0.72	0.65	1.41	Zr	160	116.4	162.6	190
FeO	4.70	3.60	3.38	3.38	Hf	—	3.48	3.3	4.9
MnO	0.08	0.06	0.05	Сл	U	1.41	1.83	1.4	1.4
MgO	1.90	2.26	1.24	1.79	Th	6.71	7.25	5.6	6.5
CaO	5.10	3.96	3.50	3.62	Sn	—	0.70	—	1.1
Na_2O	4.30	5.34	3.78	3.78	Sb	—	0.12	—	0.25--
K_2O	3.52	3.60	6.00	3.18	La	32.50	29.05	35.9	38.3
$S_{общ}$	0.30	0.23	0.24	0.13	Ce	62	57.07	68.1	76.0
P_2O_5	0.36	0.24	0.10	0.24	Pr	7.07	6.36	7.60	7.9
CO_2	2.69	2.24	0.07	1.30	Nd	26.60	24.87	26.7	29
H_2O-	Сл.	0.08	0.12	Сл.	Sm	4.75	4.15	4.52	4.5
LOI	0.34	0.56	2.64	0.59	Eu	1.70	1.26	1.23	1.1
Sum	99.68	99.67	99.58	99.62	Gd	3.61	3.81	3.14	3.4
#mg	0.27	0.35	0.23	0.28	Tb	0.49	0.39	0.36	0.41
Ppm					Dy	1.98	2.11	1.45	1.6
Cs	—	18.53	—	4.8	Ho	0.30	0.38	0.23	0.26
Li	—	14.88	—	23	Er	0.73	1.09	0.60	0.66
Be	—	1.94	—	1.4	Tm	0.092	0.14	0.08	0.088
Rb	97.10	96.90	102.6	174	Yb	0.51	0.95	0.53	0.54
Sr	816	742.9	812.1	647	Lu	0.072	0.14	0.06	0.08
Ba	1400	1953	2116	2327	Mo	—	0.83	0.2	0.49
V	64.50	64.78	67	42.5	Ag	—	70.43	<0.1	—
Cr	21.30	70.42	—	41.7	Ta	0.37	—	0.3	0.42
Co	7.29	12.55	9.6	7.5	Pb	—	17.70	9.5	19.2
Ni	15	33.61	27.2	19.3	W	—	0.44	—	7.5
Cu	—	26.93	17.4	30.2	$(La/Yb)_N$	45.7	21.9	48.6	50.9
Zn	—	70.31	60	58.2	Eu/Eu*	1.26	0.97	1.0	0.97
Ga	—	47.55	—	16.6	Nb/La	0.20	0.17	0.14	0.17
As	—	2.13	—	0.48	Nb/Ce	0.11	0.08	0.07	0.09
Sc	—	18.53	—	4.1	Th/Yb	13.2	7.4	10.6	12

Note: 1 — meta-andesite, drill-hole 636-B, depth 384.5-384.7 m (sample 89-156); 2 — meta-andesite, drill-hole 795-B, depth 392-395.7 m (sample 89-463); 3 — meta-andesite, drill-hole 625-B, depth 424.4-429.4 m (sample 89-388); 4 — metadacite, drill-hole 625-B (sample 89-381). Silicate rock analyses were carried out at IGMOF of the NAS of Ukraine, Kyiv. Contents of rare and trace elements were determined using the ICP-MS method at IMTM RAS, Chernoholovka, Russia. #mg = MgO/(MgO + FeO*).



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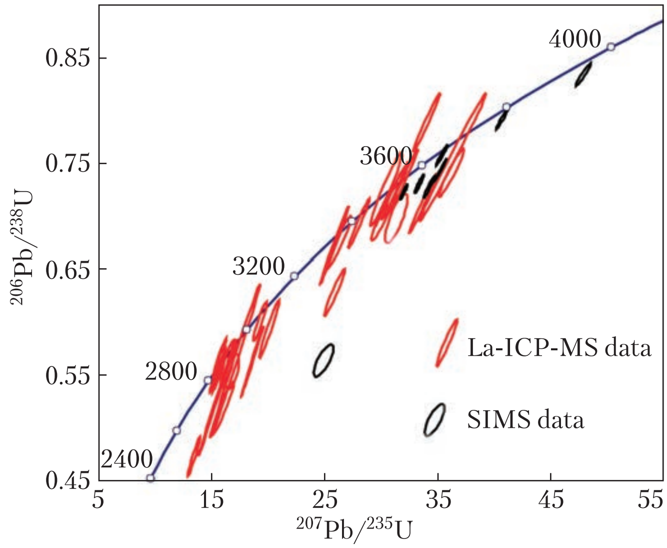

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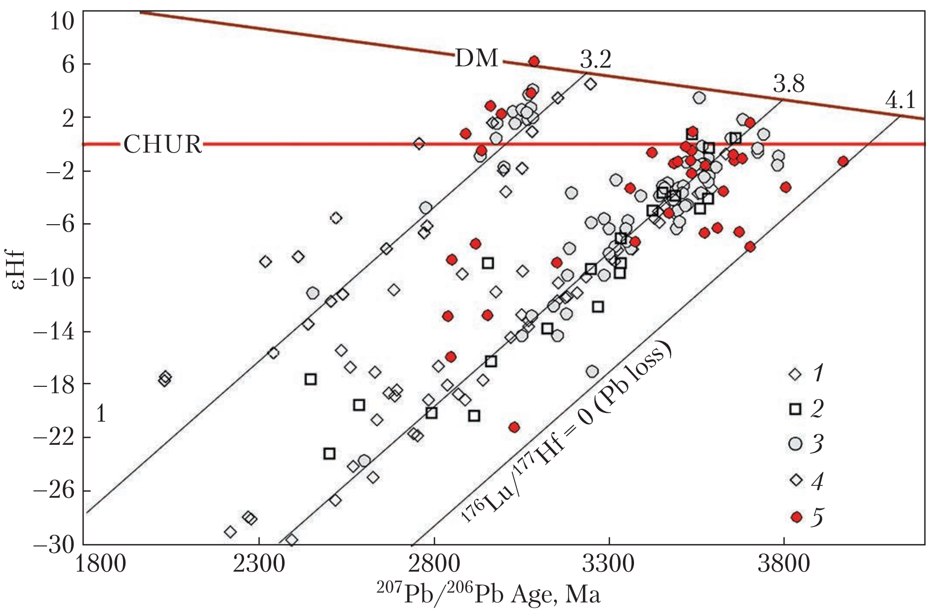

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Fig. 4. *a*: Cathodoluminescence images of the studied zircon crystals from metadacites of the Huliaipole Suite. Shown are numbers for analyzes and ages based on isotopic ratio $^{207}Pb/^{206}Pb$ (Drill-hole 625-B, depth 424,4 - 429,4 meteors, sample 89-388).
b: U-Pb diagram with concordia for zircons from metadacites of the Huliaipole Suite (Drill-hole 625-B, depth 424,4 - 429,4 meters, sample 89-388).
c: Hf isotope systematics of zircons from metadacites of the Huliaipole Syncline. Zircons from other rock complexes of the Ukrainian Shield are shown for comparison. *1* — Eoarchaean enderbite of the Dniester-Bouh Series [2]; *2* — mafic granulite of the Dniester-Bouh Series [15]; *3* — Archaean metasediments of the Azov Domain [16]; *4* — Bouh Series quartzite [9]; *5* — Metavolcanics of the Huliaypole Suite

Ni (15-33.6 ppm) and Cr (21.3-70.42 ppm), are close to their content in TTGs. Negative anomalies of Nb and Ti are highlighted on the multi-element diagram (Fig. 3, *a*). Rare earth elements in meta-andesites and metadacites are highly differentiated — $(La/Yb)_N$ = 21.9–50.9 (Fig. 3, *b*). The sample 89-156 shows a prominent positive europium anomaly, Eu/Eu* = 1.26; the rest of sample lack positive europium anomaly. The high Th/Yb ratio (7.4-13.2) and low Nb/La (0.14-0.20) indicate contamination with crustal material (Table 1). Geochemical data indicate derivation of metavolcanics of the Huliaipole Suite from the crustal magma source bearing ancient TTGs.

Geochronology. The LA–ICP–MS method was used to determine the U–Pb age and Hf isotopic composition in zircons from metadacites of the Huliaipole Suite (sample 89-388) (Fig. 4, *a*). A total of 36 zircon crystals was analyzed (Table 2). The age of the most ancient zircons was also confirmed by dating with the secondary ion mass spectrometry (SIMS) method.

According to the data obtained, two main populations of zircon can be distinguished (Fig. 4, *b*). The first population includes a group of zircons with an age in the range of 3085-2850 Ma. The Hf isotopic composition varies within wide limits: 5 crystals have εHf values from 6.2 to –0.5; other 6 have values from –7.5 to –21 (Fig. 4, *c*). Thus, zircons of this group come from rocks of different genesis: some of them were of juvenile origin, while others were formed as a result of the processing of the ancient crust. The second population includes zircons with an age of 3700-3360 Ma, which also have variable Hf isotope characteristics: from juvenile (εHf up to 1.6) and negative εHf values (down to –7.7 at an age of 3705 Ma).

In addition, two zircon crystals with the age of more than 3800 Ma were found (3805 Ma with εHf = –3.3, and 3971 Ma with εHf = –1.3). These zircons are the most ancient found in the Ukrainian Shield. Their isotopic characteristics indicate the presence of Hadean material within the Azov Domain of the Ukrainian Shield. The minimum model age for the crystallization of this material, calculated at Lu/Hf = 0 for zircons with the lowest εHf values in each age population, is about 4.1 Ga (Fig. 4, *c*).

Discussion of the results. The two main zircon populations found in metavolcanics of the Huliaipole Suite are similar in their U-Pb and Hf isotopic characteristics to zircons from the Archean metasedimentary rocks of the Soroki Greenstone Belt of the Azov Domain [2] as well as zircons from quartzites of the Bouh Group of the Dniester-Bouh Domain of the Ukrainian Shield [17]. At the same time, the older (3700-3360 Ma) zircon population corresponds in age and isotopic composition to zircons from the Eoarchean enderbites of the Dniester-Bouh Domain [2, 17].

Another intriguing observation: similarly to the iron-bearing metasedimentary successions of the Middle Dnieper Domain, no zircons younger than ca. 2800 Ma were found in the greenstone belts of the Azov Domain, and in the metavolcanics of the Huliaipole Suite (e.g., [4, 18], which supports common geological history of these two domains in the Neoarchean and Paleoproterozoic.

Finally, among the detrital zircons from the metasedimentary rocks of the Soroki Greenstone Belt of the Azov Domain [2], one zircon crystal corresponds to the most ancient zircon crystals from the metavolcanic rocks of the Huliaipole Suite in terms of isotopic and geochemical characteristics, and has a minimum hafnium model age of about 4.1 Ga. Thus, the Azov Domain of the Ukrainian Shield holds high promise for the search for Hadean zircons and the study of the early evolution of Earth.

Table 2. **Results of U-Pb isotope dating of zircons from metadacites of the Huliaipole Suite arranged in descending order of $^{207}Pb/^{206}Pb$ ages (Drill-hole 625-B, depth 424.4-429.4 meters, sample 89-388)**

# analysis	Concentration, ppm			Isotope ratio						
	U	Th	Th/U	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	Rho	$^{207}Pb/^{206}Pb$	2σ
89-388-18	176	109	0.62	49.900	2.507	0.84	0.03	0.98	0.424	0.011
89-388-29	61	38	0.62	42.280	1.157	0.79	0.02	0.98	0.389	0.008
89-388-17	165	96	0.58	44.000	1.409	0.81	0.02	0.97	0.388	0.008
89-388-14	148	76	0.51	37.430	1.096	0.77	0.02	0.99	0.356	0.007
89-388-16	188	73	0.39	37.060	0.923	0.76	0.02	0.99	0.356	0.007
89-388-22	295	74	0.25	37.080	0.980	0.75	0.02	0.98	0.354	0.007
89-388-20	171	136	0.79	38.590	1.232	0.79	0.02	0.98	0.354	0.007
89-388-9	276	85	0.31	36.400	2.412	0.76	0.05	0.99	0.350	0.007
89-388-25	245	15	0.06	36.250	0.910	0.74	0.02	0.96	0.349	0.007
89-388-34	490	7	0.01	33.720	1.009	0.71	0.02	0.99	0.339	0.007
89-388-10	357	122	0.34	31.390	0.822	0.70	0.02	0.79	0.329	0.007
89-388-6	48	16	0.33	34.070	0.984	0.79	0.02	0.99	0.314	0.006
89-388-1	70	28	0.4	31.250	0.938	0.72	0.02	0.98	0.313	0.006
89-388-5	117	83	0.71	31.060	0.843	0.72	0.02	0.98	0.313	0.006
89-388-23	60	23	0.38	32.040	1.009	0.74	0.02	0.99	0.313	0.006
89-388-30	234	170	0.73	30.330	0.957	0.70	0.02	0.94	0.310	0.006
89-388-27	209	153	0.73	30.350	0.686	0.71	0.02	0.99	0.305	0.006
89-388-7	167	39	0.23	30.480	1.120	0.73	0.03	0.97	0.303	0.006
89-388-13	624	24	0.04	25.900	0.748	0.63	0.02	0.96	0.300	0.006
89-388-31	163	76	0.47	28.060	0.752	0.69	0.02	0.98	0.291	0.006
89-388-21	201	79	0.39	26.330	0.876	0.68	0.02	0.96	0.282	0.006
89-388-35	68	52	0.76	25.920	1.030	0.67	0.03	0.99	0.280	0.006
89-388-33	193	77	0.40	20.120	0.706	0.59	0.02	0.97	0.245	0.005
89-388-26	230	244	1.07	18.620	0.820	0.56	0.03	1.00	0.235	0.005
89-388-15	187	63	0.34	19.300	0.471	0.60	0.01	0.93	0.234	0.005
89-388-12	426	38	0.09	16.020	0.825	0.52	0.02	0.95	0.227	0.006
89-388-3	97	38	0.39	16.850	0.451	0.55	0.01	0.52	0.222	0.006
89-388-28	139	32	0.23	17.100	1.832	0.56	0.06	1.00	0.218	0.005
89-388-4	129	57	0.44	16.500	0.542	0.56	0.02	0.82	0.216	0.006
89-388-2	258	119	0.46	15.500	1.336	0.53	0.05	1.00	0.214	0.004
89-388-32	512	441	0.86	16.590	0.520	0.56	0.02	1.00	0.212	0.004
89-388-11	105	5	0.05	13.470	0.450	0.47	0.02	0.97	0.208	0.004
89-388-8	63	81	1.28	15.610	0.615	0.56	0.02	0.99	0.203	0.004
89-388-19	46	71	1.54	15.680	0.485	0.55	0.02	0.98	0.203	0.004
89-388-24	39	41	1.05	15.720	0.414	0.56	0.01	0.94	0.202	0.004

			Isotopic age, Ma							
	$^{208}Pb/^{232}Th$	2σ	$^{207}Pb/^{235}U$	2σ	$^{206}Pb/^{238}U$	2σ	$^{208}Pb/^{232}Th$	2σ	$^{207}Pb/^{206}Pb$	2σ
	0.213	0.006	3986	49	3940	100	3897	78	3997	25
	0.198	0.006	3831	20	3739	59	3644	84	3865	4
	0.211	0.006	3863	25	3832	66	3866	81	3862	7
	0.212	0.007	3704	21	3662	56	3888	92	3734	5
	0.215	0.005	3695	15	3637	36	3940	50	3733	4
	0.192	0.006	3695	17	3609	47	3551	72	3726	4
	0.209	0.006	3740	22	3748	58	3831	79	3722	5
	0.217	0.019	3667	62	3620	170	4050	340	3705	9
	0.229	0.011	3677	17	3575	43	4160	170	3704	6
	0.169	0.014	3601	22	3464	66	3150	240	3656	7
	0.209	0.010	3531	17	3411	50	3830	150	3611	15
	0.218	0.008	3611	21	3749	59	3980	120	3539	8
	0.197	0.008	3526	22	3510	62	3630	110	3538	6
	0.201	0.006	3520	18	3501	48	3707	65	3537	3
	0.188	0.008	3551	24	3551	66	3490	130	3534	7
	0.187	0.005	3496	24	3432	62	3471	65	3520	10
	0.185	0.004	3498	10	3462	33	3436	33	3498	3
	0.198	0.006	3500	30	3513	88	3654	71	3486	11
	0.197	0.007	3342	20	3141	53	3635	89	3471	5
	0.183	0.005	3421	18	3394	51	3395	59	3423	5
	0.177	0.005	3358	27	3323	57	3298	67	3375	8
	0.182	0.009	3341	34	3310	100	3370	150	3363	7
	0.159	0.004	3096	29	2999	77	2976	50	3152	15
	0.119	0.023	3019	39	2902	95	2250	420	3086	4
	0.182	0.005	3056	14	3031	35	3371	64	3078	7
	0.153	0.006	2885	43	2712	64	2884	99	3029	26
	0.206	0.010	2926	17	2837	33	3790	150	2993	27
	0.166	0.013	2920	110	2860	240	3100	220	2962	12
	0.121	0.005	2905	25	2864	60	2308	78	2953	28
	0.060	0.009	2838	72	2720	180	1170	170	2936	6
	0.153	0.005	2910	24	2875	58	2879	75	2920	3
	0.067	0.013	2712	26	2511	41	1320	250	2892	11
	0.163	0.006	2851	33	2860	76	3058	79	2848	7
	0.150	0.004	2856	23	2839	52	2826	58	2852	9
	0.152	0.004	2860	16	2878	38	2864	44	2840	13

Conclusions. The Huliaipole Block of the Azov Domain of the Ukrainian Shield carries evidence for a protracted geological evolution from the Hadean to the Palaeoproterozoic. The Azov Domain indicates existence of the cratonic nucleus formed from 3.97 to 3.3 Ga ago. In the Mesoarchean (3.2-3.0 Ga), the Huliaipole Block was a part of the Middle-Dnieper-Azov-Kursk granite-greenstone terrane. Felsic and intermediate volcanic rocks of the Huliaipole Suite could have formed due to the melting of the sialic continental crust, including components of the Hadean and Archean age, as a result of the underplating by mafic magmas during the formation of Neoarchean-Paleoproterozoic extension-related rift structures.

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Received 16.11.2020

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ЕТАПИ ФОРМУВАННЯ ЗЕМНОЇ КОРИ НА ПРИКЛАДІ ГУЛЯЙПІЛЬСЬКОГО БЛОКА ЗАХІДНОГО ПРИАЗОВ'Я (4,0—2,0 млрд років)

Методом LA-ICP-MS визначено U-Pb вік популяцій циркону з метадацитів гуляйпільської світи — 3085—2850 і 3700—3360 млн років. Крім того, виявлено два кристали циркону віком понад 3800 млн років. Згідно з геологічними і геохронологічними даними, Гуляйпільський блок, який має розміри 30 × 50 км, складений породами і їх реліктами гадейського, архейського і палеопротерозойського еонів. Найдавнішим фундаментом Приазовського мегаблока є, ймовірно, породи нуклеарної структури, яка формувалася від 3,97 до 3,3 млрд років. У мезоархеї (3,2—3,0 млрд років) вона стала частиною Середньопридніпровсько-Приазовсько-Курського граніт-зеленокам'яного терейну. Вулканіти кислого і середнього складу гуляйпільської світи могли утворитися внаслідок плавлення порід сіалічної кори, що включала породи гадейського і архейського віку, в результаті андерплейтингу базитових розплавів під час формування неоархей-палеопротерозойських рифтогенних структур.

Ключові слова: *Західне Приазов'я, Гуляйпільський блок, гадей, архей, палеопротерозой, Український щит, U-Pb вік.*