

Evaluation of possible tailings' seal failure within Dniprodzerzhynsk industrial agglomeration (Ukraine) on the basis of the neotectonic data

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The study area is located within Dniprodzerzhynsk industrial site in the Dnipropetrovsk region of Ukraine. At this place, since 1949 to 1991, State Industrial Enterprise «Pridneprovskiy Chemical Plant», was one of the largest metallurgical facilities where uranium ores were processed. When the enterprise stopped its activity, seven tailings and two storages of uranium waste were formed on the territory and beyond. At present, about 42 million tons of waste with total activity 3.2×10^{15} Bq (86,000 Ci) is accumulated in tailings (Verkhovtsev *et al.*, 2010).

Neogeotectonic study of this area allows determining the degree of influence of recent activity geostructures features and their activation on rock properties (physical, mechanical, filtration and others) on which objects of study are located. Therefore it allows identifying the possible direction of migration of radionuclides and toxic compounds in groundwater aquifers and mines.

Neotectonic mapping was made on the basis of morphostructural methods in a scale of 1:25 000 (Yuskiv & Verkhovtsev, 2013).

21 lineament zones (LZ) were identified by the group of researchers. These zones are ranked as regional and local. Lineaments form two dominant systems – orthogonal ($0^\circ \perp 90^\circ$, $\pm 5^\circ$) and diagonal ($40\text{--}45^\circ \perp 310\text{--}315^\circ$), two intermediate diagonal systems ($25\text{--}30^\circ \perp 295\text{--}300^\circ$; $74\text{--}80^\circ \perp 345\text{--}350^\circ$) and one depressed area ($15\text{--}20^\circ$) with single lineament zone (Fig. 1.) were identified.

12 ring structures (RS) active on the latest stage (Late Pliocene–Quaternary) were allocated: nine inherited, two non-inherited and one intermediate morphogenetic types. Their sizes are from 3936x2198 m to 10474x7678 m, and the estimated (calculated) depth – from 1158.4 to 5237 m.

Analysis of summary amplitudes late Pliocene–Quaternary vertical crustal movements shows that within the study area they have differentiated and highly significant intensity (maximum values exceeding +95 m).

Definition of influence identified active geological structures on the safety of uranium tailings production, prediction of places of active absorption of polluted water by neotectonic data. The most dangerous areas are allocated in combination with the neotectonic parameters: the presence of LZ (active on the neotectonic stage of faults development), the presence of local, usually positive RS; coincidence with LZ and positive RS local anomalies of summary amplitudes increased values.

Tailing “Dniprovsk” is located in a dangerous place by neotectonic criteria. It is confined to the node intersection of three LZs: №3, №11 and №16. Especially dangerous zones are №3 and №11 because the migration of contamination is supposed by them (to the north and north-east). The RS №2 and 3 affect directly at the tailing as it is located at their peripheral parts. At the same time, by vertical movements, it is a relatively quiet place and characterized by summary amplitudes of +5 m or less.

Tailing “Zakhidne” and “Central Yar” are located directly within the local LZ №3 and №3 RS, and they are probably the ways of active contamination migration.

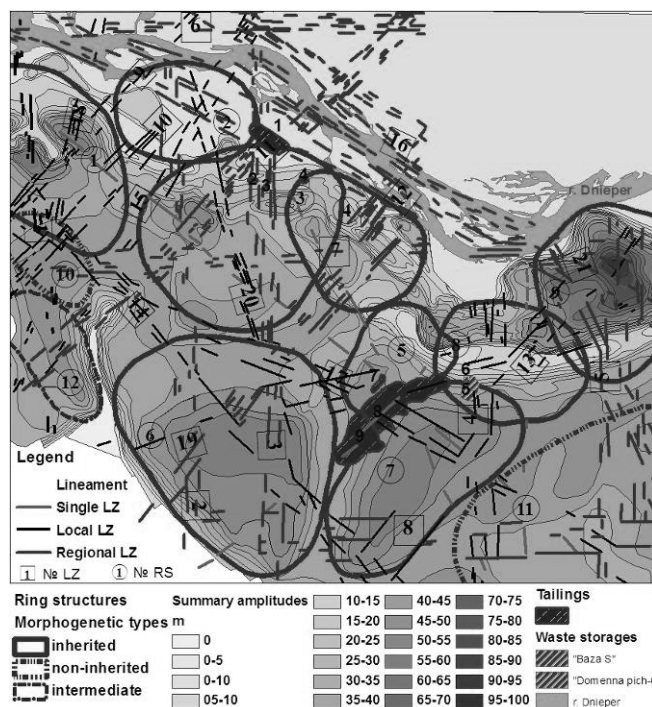


Fig. 1. Neotectonic map of the territory of uranium production legacy site at Dniprodzerzhynsk (Yuskiv & Verkhovtsev, 2013). Scale 1:25 000 (reduced).

Legend: Tailings and waste storages of uranium production:

- 1 – «Dniprovsk», 2 – «Zakhidne», 3 – “Central Yar”, 4 – «Pivdenno-Skhidne», 5 – «Baza S», 6 – «Domenna pich-6», 7 – «Lanthanum fraction», 8, 9 – «Sukhachivske» (1st and 2nd sections).

Tailing “Pivdenno-Skhidne” is located in the best neotectonic conditions.

The rise of radionuclides migration is assumed on the territory where the tailings “Lanthanum fraction”, “Sukhachivske” (1st and 2nd section), “Domenna pich-6”, “Baza S”. It is caused by the influence identified LZ №4, 17, 19 and the erosion form associated with the tailings. Tailing “Sukhachivske” is framing at RS №7 and a crossing is also observed at RS №5, 8, 7. Average summary amplitude by height is +40–50 m, so they, presumable, have some minimal impact.

Verkhovtsev V.G., Lysychnenko G.V., Yuskiv Y.V. (2010): Sci Pap «Geochem Ecol», 16 (in Ukrainian).

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