

Mineral Forms of Thallium and the Genetic Model of the Vorontsovskoe Gold Deposit (North Urals, Russia)

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The Vorontsovskoe gold deposit is located in Sverdlovsk region in Northern Urals (Russia), about 310 km north of the Ekaterinburg city. The Vorontsovskoe deposit was discovered in 1985 and actively mined for gold during 1999–2020. Total of the gold content of the deposit was initially estimated *ca.* 101 t (with 7 g/t Au on average). Two main primary ore types were exploited: disseminated pyrite ore with low Au grade and more rich veinlet ore presented by carbonate breccias with orpiment-pyrite-realgar cement. Gold in breccias associates with extremely specific Tl-Hg-Mn-As-Sb-S mineralization, which makes Vorontsovskoe a unique gold deposit both in Russia and the world.

Thallium is an indicator element of renowned Carlin-type Au–Tl–As–Hg–Sb deposits such as Carlin (US), Allchar (North Makedonia) or Lanmuchang (China). Other crucial localities with specific minerals of Tl are related to metamorphic carbonate rocks: the Lengenbach quarry (Switzerland) or Monte Arsiccio mine (Tuscany, Italy). The thallium mineralization of the Vorontsovskoe deposit includes 33 mineral species, which characterizes it as the second rank locality after Lengenbach. Thallium minerals of the Vorontsovskoe deposit are predominantly sulfosalts, seven of them were discovered as new mineral species in the past decade. The presence of Mn is a distinctive feature of low-temperature thallium mineralization of the deposit. The source for Tl remains uncertain.

According to previous comprehensive structural, mineralogical, and geochemical studies of the Vorontsovskoe ores, two genetic models are proposed: Carlin-type and «jasperoid»-related. Thus, the true nature of Vorontsovskoe's origin is still debatable.

On the basis of detailed analyses of previous works and new mineralogical data we propose the new view for an origin of the deposit as an epithermal object relating to a late stage of formation of the Auerbach gabbro-diorite-granite complex.