

INTRODUCTION



1. Geographical location of the Murzinskoe gold deposit (asterisk) shown on maps of:
(a) Altai Krai, and
(b) Krasnoshchekovo district.

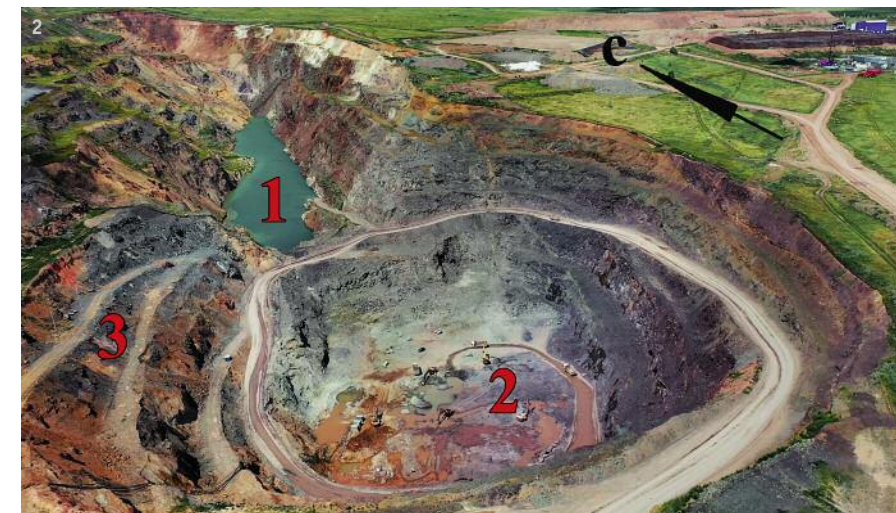
Murzinskoe gold deposit, one of the few deposits currently in operation in Altai Krai, is located in the western part of the Krasnoshchekovo district, on the southeastern slope of Murzinka Mountain, after which the deposit was named. The nearest settlement, the Akimovka village, is located 2 km to the southwest, hence the alternative name of the deposit, Akimovskoe. The district center of Krasnoshchekovo is located 10 km to the northeast (Fig. 1).

Murzinskoe was initially discovered as a copper deposit in 1740 (or, according to some sources, in 1734) by steward Rheiver. Subsequently, Akinfei Demidov began the construction of two Murzinka mines. In 1746, silver was identified in the ores, and the Murzinskoe mines were transferred to the Imperial Cabinet (Cabinet of His Imperial Majesty), along with all other mining operations in Altai. Exploration and mining activities were initially carried out using small pits and mines (up to 13 meters deep) using crosscuts and crossdrifts. During these periods, 786.24 tons of sorted ore containing 2.5% Cu and 133 g/t Ag, were produced and traces (signs) of gold were found, however production was likely much higher. During these years, miners regularly observed gold as powdery particles and occasionally as irregular-shaped inclusions up to 1 cm in size. The ore zones were thought to consist of mineralized, primarily skarned rocks, interspersed with quartz veins containing high-grade copper-silver pods. The ore quality at that time was primarily determined by the copper content, and production would cease if the copper grade in the veins decreased, even if gold was present. By 1847, nearly all of the high-grade ore bodies had been exhausted at the surface and to a modest depth.

In 1910, the economic gold potential of the Murzinskoe ore zone was recognized, and from 1910–1914 and 1934–1951, gold became the primary product. A group of gold-bearing quartz veins was developed through two mines. The gold content at various mining levels ranged from 3.9 to 11.4 g/t. However, in 1951, due to increased costs for linings and pumping, along with a decline in gold grade at greater depths, mining ceased, and the pits were abandoned (Gusev, 2014; Murzin *et al.*, 2015).

Exploration in the Murzinskoe ore field was resumed in 1987, and mining operations commenced in 1994, and are still ongoing today. Mining is currently being conducted by the Prospectors' Crew "Poisk" LLC. It is important to note that modern geological literature (Gusev, 2014; Murzin *et al.*, 2015; Gusev and Tabakaeva, 2017) references several geological objects named Murzinskoe within the area. The namesake ore field, covering 54 km², is situated on both the left and right banks of the Talovka River and consists of three deposits—Murzinskoe-1, Murzinskoe-2 (sometimes referred to as a prospect), and Murzinskoe-3 — as well as several deluvial-eluvial gold placers. The numbering of the Murzinskoe deposits corresponds to the designations in the li-

2. Open pit of the Murzinskoe deposit.
Red numbers:
(1) Northern area with pond,
(2) Southern area, and
(3) dumps.
August, 2024. Photo: Nikolai V. Bail.



All specimens:
Phosphatno-Arsenatnaya vein,
Murzinskoe gold deposit,
Altai Krai, Russia.

cense application of the Prospectors' Crew "Poisk" LLC. Our work is focused on the operating Murzinskoe-1 deposit. The Murzinskoe-2 and Murzinskoe-3 deposits are located 1.5 km and 5 km to the northeast of Murzinskoe-1, respectively. The Murzinskoe-2 deposit has been explored using boreholes and trenches, and old galleries have been developed within the area. Murzinskoe-3 was mined via open-pit methods and is currently undergoing reclamation. Due to the very low gold grades in the ores of both the Murzinskoe-2 and Murzinskoe-3 deposits, there are no plans to renew production at these deposits.

The Murzinskoe-1 deposit (hereafter referred to as Murzinskoe for simplicity) is mined using open-cast methods. The open pit covers an area of 0.5 km² (1.5 x 0.33 km) and extends from south to north. It is delineated by the following coordinates: 51°35'29.5" N, 82°36'51.2" E (west); 51°35'43.2" N, 82°36'34.9" E (east); 51°36'08.3" N, 82°36'28.9" E (north); and 51°35'21.3" N, 82°36'45.1" E (south). The Northern area of the open pit was mined until 2022, and its floor is now submerged, forming a pond. Currently, mining is focused on the Southern area. These two areas of the open pit are separated by a narrow dam. The dumps are located on the western side of the pit (Fig. 2). The primary product of interest is gold, with silver as a by-product. Two types of ore are extracted, quartz-sulfide-gold (from quartz-sulfide veins and skarns) and the weathering profile. According to official data from "Seligdar" PJSC, which includes the Prospectors' Crew "Poisk" LLC, a total of 419 kg of gold was produced from the deposit in 2023. As of January 1, 2024, the proven reserves (C1 + C2 according to Russian classification) amounted to 1031 kg (<http://seligdar.ru/operations-and-projects/gold-division/poisk>).

The Murzinskoe deposit has been inadequately described in terms of mineralogy. While its geology and geochemistry have been studied in detail (Babich *et al.*, 2006; Gaskov *et al.*, 2010; Gusev, 2014; Murzin *et al.*, 2015; Gusev and Tabakaeva, 2017; Gusev and Gusev, 2018, and others), very few mineralogical studies of this deposit were completed before this work. In the existing publications, evaluations of the "mineralogical component" of this deposit are generally limited to brief descriptions of only a few minerals, primarily the major ore and gangue minerals, with occasional reference to minor and rare constituents. These descriptions typically do not involve analytical data or identifying characteristics.

In terms of mineralogical studies, we previously reported the discovery of several rare minerals at the Murzinskoe deposit in the "*Mineralogical Almanac*." These include ferrihollandite (Kasatkin, 2019), as well as brendelite, zalesiite, likasite, rouaite, spertiniite, roxbyite, phosphohedyphane, and cesàrolite (Kasatkin, 2021). Notably, the discoveries of brendelite, zalesiite, roxbyite, spertiniite, and ferrihollandite were the first recorded in Russia. Additionally, Zubkova *et al.* (2022) provided a detailed report on a new copper phase, Cu₃(OH)₃[SO₃(NH₂)], found in the deposit's oxidation zone as a result of reaction of copper sulfides with the chemical compounds from the explosives.

Since 2016, the authors of this publication, in collaboration with colleagues from Russia, Italy, and the Czech Republic, have been conducting systematic studies of the mineralogy of the Murzinskoe deposit. During this period, we have identified 247 mineral species through analytical methods, including 147 supergene minerals. Notably, two new mineral species were discovered: lednevite (Kasatkin *et al.*, 2024) and stibiosegnitite (Kasatkin *et al.*, 2025). Additionally, 29 minerals were found for the first time