Minerals in Afghanistan

Baryte in Afghanistan

Introduction

Afghanistan is situated on the junction between the Indian and Eurasian crustal plates and is composed of a series of terranes (Figure 1) that broke away from the main Gondwana supercontinent before colliding with and being accreted onto the Eurasian plate. The accretionary events started in the Cretaceous and have continued until recent times. The Herat fault marks the boundary between Eurasia to the north and the first of these accretionary terranes, the Farad block, to the south; the intervening Paleo-Tethys ocean having been subducted under the Eurasian continent.

Baryte is a widespread mineral in Afghanistan but major occurrences and deposits are restricted to an E-W zone along the major Herat fault (Figure 1). The major deposits are located in Herat Province but other significant prospects are located further to the east in Ghor and Kapisa Provinces. Most of the deposits are vein-style and may be related to MVT lead-zinc deposits.

The major use of baryte is as a drilling mud in petroleum exploration, with about 1400 to 3500 t being used each year per drilling rig. If active exploration for oil and gas takes place in Afghanistan then around 25,000 t/year will be required and exports to neighbouring countries, like Tajikistan, may double this demand to ~50,000 t/year.

Geology of the Herat baryte area

The Farad block to the south of the Herat fault has basement rocks of Proterozoic and Paleozoic age and a cover sequence of Permian to Mesozoic age (Figure 2). The Triassic rocks in this sequence are deep-water sediments such as cherts and volcanics and are followed by Mesozoic limestone, marl, sandstone and conglomerate. After collision between the two blocks, a Palaeogene to Neogene sequence of mainly terrigenous sediments was laid down across the area. Within the Herat fault zone localised grabens were formed in the Paleogene and andesite to rhyolite lavas and tuffs were erupted. The baryte deposits occurrences are associated with splay faults off the main Herat fault, which strike at high angles NW-SE in the case of the Sangilyan, Guron and Gardani-Burida occurrences and NE-SW in the case of the Zanda Jan (Zandadshon) occurrence.

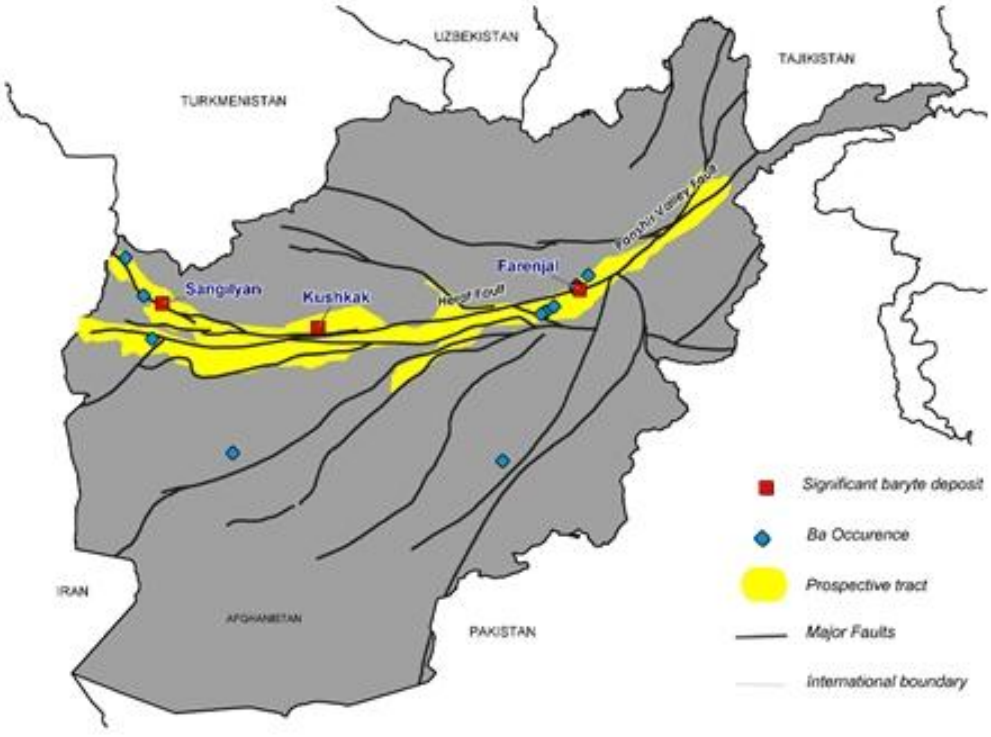

Figure 1. Tectonic sketch of Afghanistan showing the location of the baryte deposits

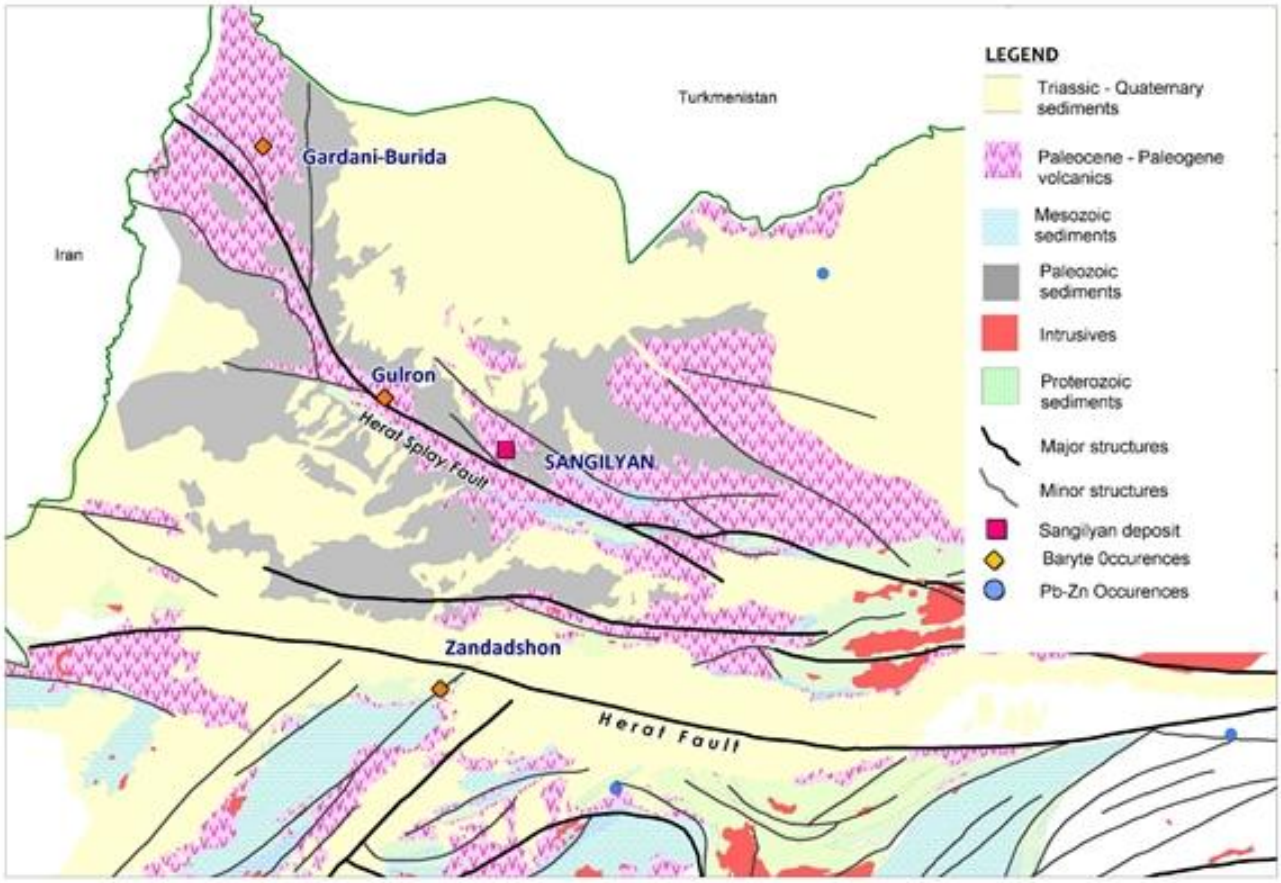

Figure 2. Geological sketch map of the Herat baryte area and location of the Sangilyan deposit.

Geology of the Sangilyan baryte deposit

The geology of the Sangilyan baryte deposit area is composed of two pre-mineral rock-units; Paleocene volcanoclastics unconformably overlain by Miocene terrigenous sediments. The volcanoclastic unit (Galachagar Formation) is about 400 meters thick and comprises greenish grey tuffaceous lava, lava-breccia, tuff breccias, conglomerate, and andesite-dacite lava. The terrigenous sediments (Lykisan Formation) reach 250 meters in thickness and comprise dark red-pink conglomerate, gritstone, sandstone and siltstone. These units are invariably overlain by Quaternary unconsolidated sediments. The veins and the controlling structures crosscut all the stratigraphic horizons except the Quaternary sediments (Figure 2).

The Herat fault is a major, pre-mineral structure that is the first order control on the hydrothermal baryte-calcite-basemetal mineralisation (Figure 1), and in this area it strikes east-west for over 100 km and is dipping steeply (75-80^{o}). High-angle, nearly E-W, NW-SE trending, closely spaced, sub-parallel faults, shears and joints branch off the main fault and are the primary mineralised structures. The ore controlling nature of the structures is manifested by the presence of baryte vein deposits trending NW-SE, N-S and rarely E-W, which is sympathetic with the general trend of the Herat fault splays.

Exploration history

Baryte occurrences near Sangilyan were first noticed by Afghan-Soviet geologists in 1968 whilst undertaking 1:500,000 scale geological mapping in the area for hydrocarbons. Significant baryte veins of 50-100 m length and 0.2-4.4 m thick were reported. These assayed 87-93% baryte with an initial resource estimate of 30,000 tons.

Subsequent work in 1972 reported the presence of numerous baryte veins with strike lengths of up to 250 m and thicknesses of 0.4-4.0 m, with a baryte content ranging between 74-94.2%. Consequently, detailed re-assessment culminating in drilling and resource estimation (Table 1) was undertaken during 1972-73 (Chmyriov, 1973).

Mineralisation

Mineralisation at Sangilyan covers an area of over 3 km^2 and is hosted within Eocene-Oligocene volcanics and sediments. There are three major mineralised zones incorporating over 30 steeply-dipping tabular baryte veins, up to 2,500 m long and 200-700 m wide. Individual veins and orebodies within these zones are 70 to 1,000 m long, 0.4 to 6 m thick and extend to a depths of 150 m. Wall rock alteration is weak with minor silicification and carbonate alteration up to 5 m away from the veins.

Table 1. Summary of the resources of the Sangilyan baryte deposit (Chmyriov, 1973)

Soviet Category	Tons	Grade (%)	% of total
A	165,000	91.4	9.7
B	702,600	86.6	41.5
C_1	310,800	81.8	18.4
C_2	315,000	-	18.6
Speculative	200,000	-	11.8
Total	1,693,400	85.6-91.8	100.0

Kushkak occurrence, Ghor Province

The Khushkak baryte occurrence is located about 240 km east of the Sangilyan deposit in a similar structural setting. Khushkak occurrence has been described as a stratiform deposit hosted within Upper Cretaceous limestone, adjacent to a splay fault and intimately associated with Cu±Pb±Zn sulphides. Grab samples returned assays up to 52.24% baryte and 6.03% Cu. The baryte body is estimated to be 60 x 120 m in size (Abdullah and others, 1980). Unlike the Sangilyan deposits, several stratiform Pb-Zn occurrences occur within the immediate vicinity of the area suggesting a strong spatial and genetic relationship.

Farenjal deposit, Parwan Province

The Farenjal baryte deposit is located in Parwan Province and is a stratiform baryte-lead-zinc deposit of Neogene age. It consists of sheet-like bodies of mono-minerallic baryte, baryte-lead-zinc and lead-zinc ores within brecciated Paleozoic rocks (Figure 3). The deposits are hosted by phyllites and slates with intercalations of sandstones and limestones. These units are folded and intruded by ultrabasic rocks (serpentinite, chlorite-talc-schists and diallage-gabbros), which are locally metamorphosed. The limestone unit is estimated to be 200 m in thickness and is probably of ?Late Carboniferous age as defined by the foraminefera fusulina, (Hunger, 1960). Hunger described three types of mineralisation:

- **Fissure and breccia filling** - mainly occur as baryte crystal in-filling walls of open fractures and as matrix-infills of limestone breccias. This type has limited exploitation potential and was not mined.
- **Dykes** - These occurrences are widespread and occur at several locations including the mined areas. The bodies strike north-south and steeply dip to the east and their thickness ranges from 10 cm to over 3 m. These dykes were exploited in the 1960's at several localities.
- **Residual deposits** - constitute the major resource mined at Farenjal, where baryte occur as residual concentrations within Pliocene marl or marly sandstone. Approximately 3,000 tons of mineable resources were estimated in 1960.

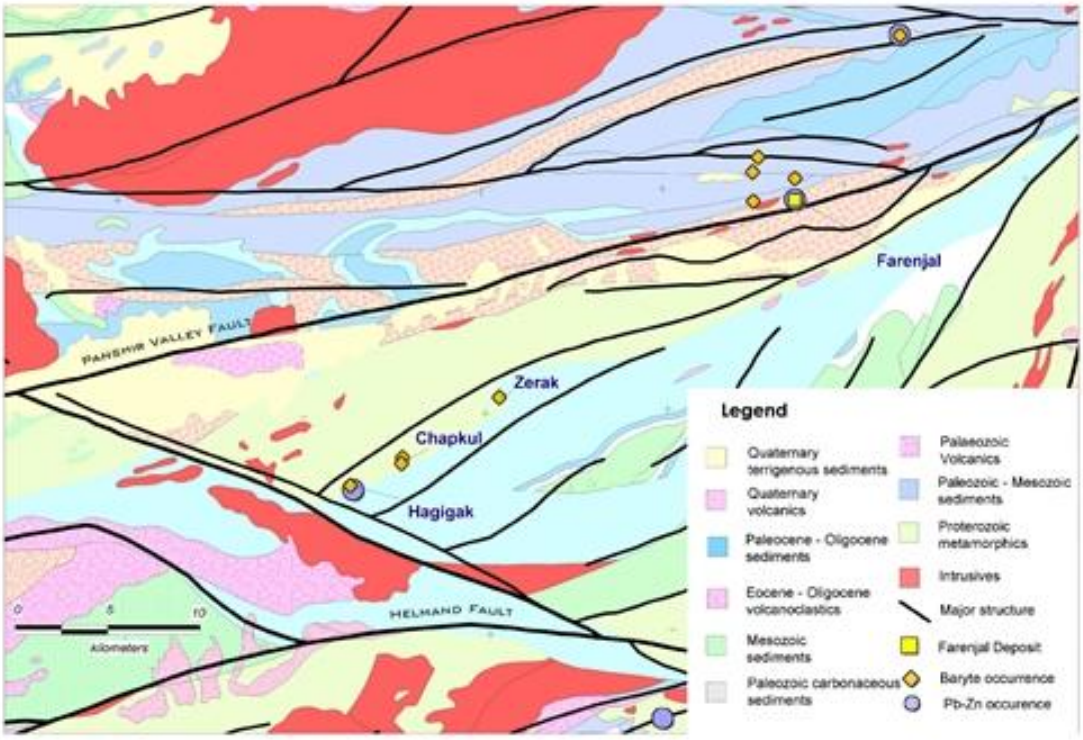

Figure 3. Geological map of the Farenjal baryte occurrence

Speculative resources at Farenjal are estimated to be 150,000-200,000 tons baryte at 83.7% $BaSO_4$, and 25,000-30,000 tons lead-zinc ore at 2-9% (Pb+Zn) (Kazak et al., 1965).

Baryte Metallogenesis

The baryte occurrences are epigenetic and most are described as vein-style fracture fillings or breccias. There is a strong spatial correlation with the major Herat fault and direct control by splay faults off the main E-W fault zone. Also the Paleogene andesite to rhyolite rocks are commonly associated with the deposits, which are, however, hosted by adjacent sedimentary rocks ranging from Carboniferous to Miocene in age. An origin is proposed involving leaching of the barium from the volcanic rocks by hydrothermal fluids, which rise up the main fault zone and react with younger sulphate-bearing meteoric fluids of probable Miocene age. Deposition occurs in open fractures on splay faults off the main suture.

Resources in Afghanistan

Sufficient resources for the oil and gas industry exist in the Sangilyan area, which could support a medium sized open-pit mine producing about 50,000 t/year of drilling mud grade. This should satisfy domestic demand and possible exports.

Figure 4. Baryte from the Sangilyan deposit

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Summary of the potential of the Baryte resources of Afghanistan

- **Estimated resources at Sangilyan of 1.7Mt at >85% $BaSO_4$**
- **Speculative resources at Farenjal of 150,000-200,000 tons baryte at 84% $BaSO_4$**
- **Sufficient resources of drilling mud grade baryte for oil and gas exploration probably exist at Sangilyan for over 30 years production at rates of 50,000 t/year**

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