U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
Afghan Geological Survey
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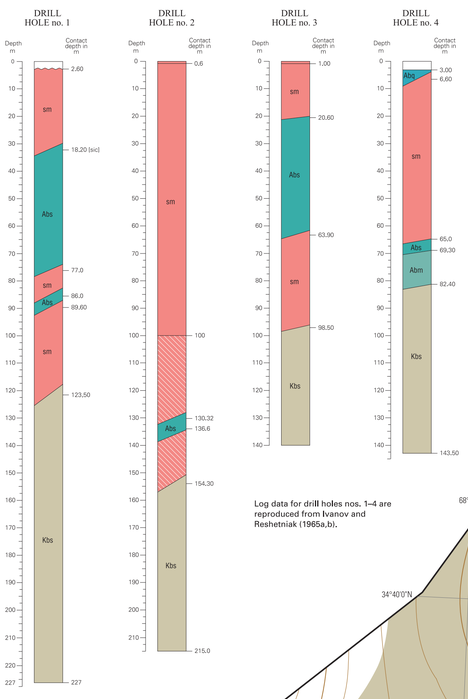


Log data for drill holes nos. 1–4 are reproduced from Ivanov and Reshetniak (1965a,b).

Topography derived from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) 30-meter Global Digital Elevation Model (GDEM) data, 2009
Hydrography derived from ASTER GDEM data
Projection and 15-second grid: Universal Transverse Mercator (UTM), zone 42 north
World Geodetic System (WGS) 1984 Datum

N

SCALE 1:4 000

1000 0 1000 FEET
500 0 100 200 300 400 500 METERS

CONTOUR INTERVAL 25 METERS

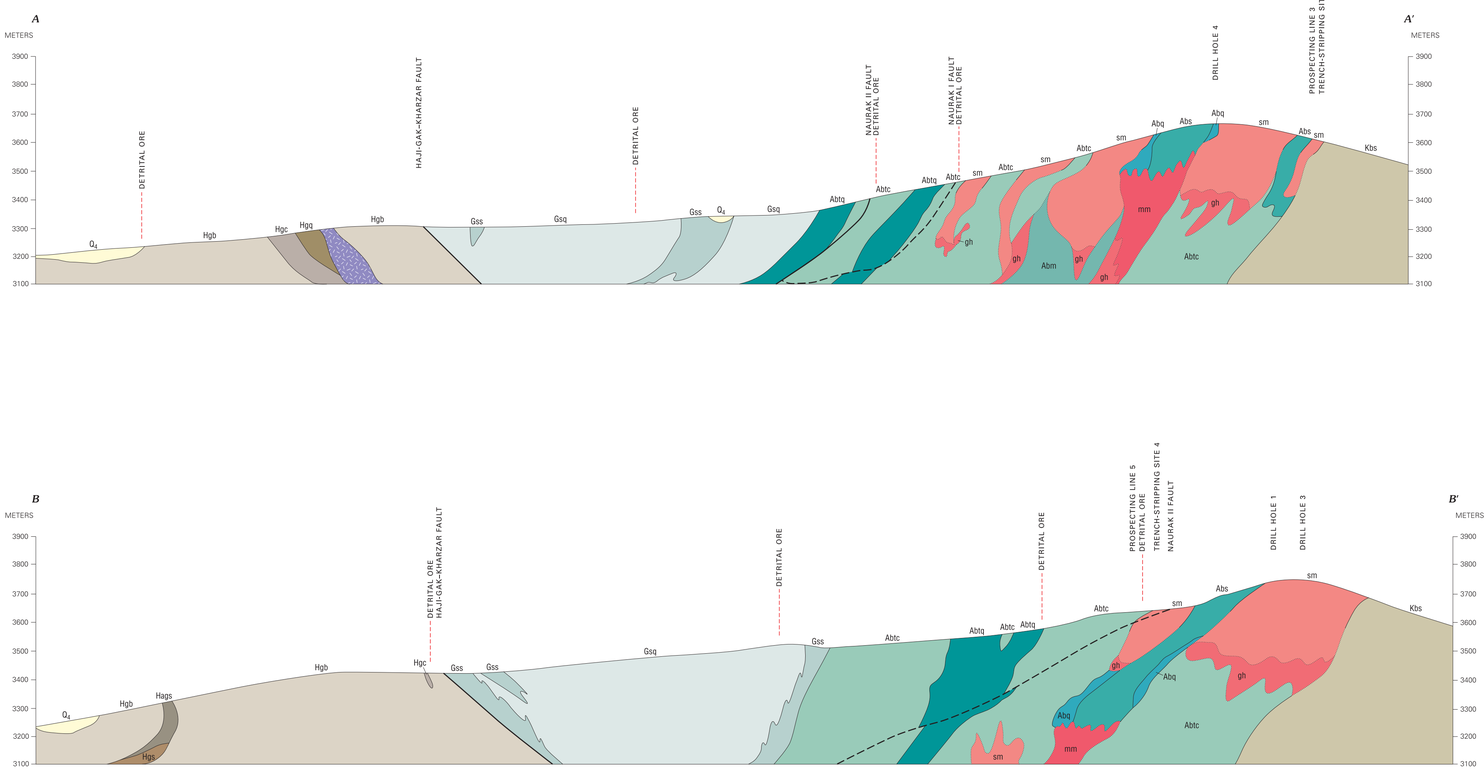
Modified from original compilation of Reshetniak and Kusov (1965); see References Cited

INTRODUCTION

This map is a modified version of *Geologic-prospecting plan of western area of Hajigak iron-ore deposit*, scale 1:2,000 (Reshetniak and Kusov, 1965). The original map is one of several that are contained in volume 3 of Soviet report no. R0600, which was prepared in cooperation with the Ministry of Mines and Industries of the Royal Government of Afghanistan in Kabul in 1965 under contract number 640, signed on November 24, 1962. This modified map illustrates the geological structure of the western Haji-Gak iron deposit and includes cross sections of the same area.

The unit colors on the map and cross sections differ from the colors shown on the original version. The units are colored according to the color and pattern scheme of the Commission for the Geological Map of the World (CGMW) (http://www.ccgm.org).

This map reproduces the topology (contacts, faults, and so forth) of the original Soviet map and includes modifications based on our examination of that document. We constructed the cross sections from data derived from the original map. Elevations on the cross sections are derived from the original Soviet topography and might not match the newer topography used on the current map. We have attempted to translate the original Russian terminology and rock classification into modern English geologic usage as literally as possible without changing any genetic or process-oriented implications in the original descriptions. We also use the age designations from the original map.



DESCRIPTION OF MAP UNITS

Q_4 **Flood-plain and alluvium deposits (Holocene)**—Pebbles, boulders, talus, and abundant fragments of iron ore. The upper part of the flood-plain deposits consists of peat bogs 0.2 to 1.0 m thick. The thickness of these deposits does not exceed 20 m
Elvium-diluvium deposits (colluvium)—Loamy sand including iron-ore fragments. Mostly 0.2 to 0.5 m thick, but as much as 17 m thick on moderately dipping slopes

Haji-Gak Formation (Upper Devonian)—Located in the southern part of the ore field of the Haji-Gak iron deposits. The type of the boundary between the Haji-Gak Formation and the Green Schist Formation is unclear because it is on the Haji-Gak–Kharzar fault. Limestones contain abundant fossils. According to the fossil fauna, the age of the Haji-Gak Formation was determined as Upper Devonian. The thickness of the formation is 900 m

Hgb **Limestones**—Main part of the Haji-Gak Formation; dark-gray and black, dense, thinly to thickly laminated, aphanitic, in places coarse-grained; highly reactive with HCl. These rocks are injected by a dense net of white, coarsely crystalline barite veins. Size of limestone grains is 0.05 to 0.1 mm. Limestone contains subrounded, fine- to medium-grained quartz (3 percent), and remnants of shells coated with coarse-grained calcite. Some limestone is composed of cryptocrystalline rounded calcite with pseudo-oolitic structure (roundish or spherical particles 0.1 mm in diameter, which lack radial or concentric internal zoning)

Hgc **Limy breccia-conglomerates**—Lenses and beds (from 1 to 100 m thick); brownish-gray and lilac-colored, spotted, massive and poorly laminated rocks; composed of unsorted and poorly rounded pebbles of dark-gray limestones, in parts clayey shale, phyllites, quartzite, and quartz. Pebble size is 0.5 to 10 cm. Cement is composed of microcrystalline quartz aggregate and fine- to medium-grained quartz. Clastic content of the cement is from 10 to 80 percent. Brown iron hydroxides are highly abundant

Hags **Sandy limestones and limy sandstones**—Gray and dark-gray, dense platy rock, weakly reactive with HCl; layers are from 1 to 10 m thick; arenaceous and pelitic texture; consists of subrounded quartz grains (0.01–0.2 mm). Cement is composed of fine-grained carbonate including flakes of sericite and hydromicas, and fine-grained quartz

Hgq **Quartz sandstones**—Light-gray, fine-grained, massive, fractured rock with calcite coating along the fractures; is the middle part of the Haji-Gak Formation; beds are approximately 90 m thick; 90 to 95 percent of rock has arenaceous texture. Rock composed of rounded and subangular quartz grains and scarce feldspars (0.1–0.5 mm). Cement consists of sericite, hydromica, iron hydroxides, and calcite

Hgs **Limy argillaceous shales**—Dark-gray, unconsolidated, and reactive with HCl; constitutes scarce thin layers among limestones of the Haji-Gak Formation. Rock has sandy, fragmental, and pelitic texture; is composed of hydromica and sericite (65 percent) and carbonates (30 percent), with mixture of fine- to medium-grained quartz and coaly particles

Green Schist Formation (Middle and Lower Paleozoic)—Located in a hanging wall in the Haji-Gak deposit. Overlies and has a gradational contact with the Awband Formation. Composed of plagioporphyrites and quartz plagioporphyrites, with mylonitized and brecciated limestone as thick as 5 m at the base. The boundary between the top of the Green Schist Formation and the bottom of the Haji-Gak Formation is unclear because it is on the Haji-Gak–Kharzar fault. The rocks are hydrothermally altered in some places and contain lenses and veins of iron ore. The thickness of the entire Green Schist Formation is 700 m. Volcanic rocks are schistose, and are altered into quartz-chlorite and quartz-chlorite-sericite schists by regional and contact metamorphism

Gsq **Quartz-chlorite-sericite and quartz-chlorite schists (derived from volcanic rocks)**—Greenish-gray and dark-green schistose, poorly laminated rocks injected by quartz, magnetite-hematite, quartz-chlorite-hematite and carbonate veins with relict porphyritic texture. Phenocrysts (from 0.3 to 2.5 mm) of plagioclase (oligoclase-andesine); in places phenocrysts are made of quartz and dark-colored minerals and are entirely replaced by aggregates of chlorite, carbonate, and epidote. Plagioclase phenocrysts are replaced by sericite, quartz, epidote, carbonate, chlorite, and pelite. As a result of cataclastic processes the phenocrysts are broken into pieces and displaced. Greenschists based on their mineralogical content are related to plagioporphyrites and quartz-plagioporphyrites, and with volcanic rocks they compose the main part of the Green Schist Formation; are especially widely developed near the Haji-Gak–Kharzar fault; gradually transition from one rock into another

Gss **Quartz-sericite schists (formerly tuffs and tuffites)**—Gray and brownish-gray schistose rocks with fragmented fine-grained lepidoblastic and fragmented fine- to medium-grained textures; contain subangular grains (from 0.01 to 0.1 mm). Unit composed of quartz (70 percent) and feldspars (28 percent); in parts contains zircon and tourmaline. Cement composed of microcrystalline aggregates of sericite, hydromicas, chlorite, quartz, carbonate, and ore minerals. Unit appears in the upper part of the Green Schist Formation in lenticular layers as much as 10 m thick

Awband Formation (Middle and Lower Paleozoic)—Abundant in the middle part of the Haji-Gak iron deposit. Overlies and has a gradational contact with the Kab Formation. The Awband Formation is hydrothermally altered and hosts tabular and lenticular forms of iron-ore bodies. The age of the suite was not determined because the rugose coral that was found in carbonaceous, black crystalline limestone is poorly preserved. The entire thickness of the Awband Formation varies from 80 to 700 m

Abs **Sericite and quartz-sericite schists**—Gray and light-gray schistose rock with greasy feel and very fine grained lepidoblastic, granoblastic and relict pelitic texture; contains hydromica and sericite (35–80 percent), quartz (20–45 percent), chlorite (as much as 10 percent), carbonate (as much as 15 percent), iron-ore minerals (as much as 10 percent), and coaly material (as much as 10 percent). Unit is abundant in the western and central area of study; is host rock for iron-ore bodies or is interlayered within iron bodies

Abq **Sericite quartzite**—Gray, in some places spotted and laminated, dense, fractured rocks with quartz and quartz-hematite veins; fine-grained lepidoblastic and granoblastic texture, in parts relict porphyritic texture with phenocrysts (0.01–0.1 mm); contains sericite and hydromica (35–85 percent), quartz (15–50 percent), iron-ore minerals (as much as 10 percent), and chlorite, barite, apatite, sphene, and tourmaline

Abtq **Sandy quartz-sericite schists (derived from acidic tuffs and tuffites)**—Constitutes the hanging wall of the Haji-Gak deposit, especially the eastern area; greenish-gray and gray, fragmental coarse-grained or thin schistose fine-grained sandstone-like rocks with fragmental sandy psammitic and relict psammitic texture; contains subangular and subrounded corroded quartz grains and feldspars (0.1–0.8 mm). Cement contains fine flakes of sericite and chlorite aggregates, and fine-grained quartz (0.01–0.05 mm), scarce ore minerals, tourmaline, carbonates, epidote, and apatite

Abtc **Carbonate-chlorite-sericite schists (derived from primary tuffs and tuffites)**—Dark-green and greenish-gray schistose soft rock, very fine grained, granolepidoblastic, and fragmental fine- to medium-grained and vitroclastic, with pyrite impregnations; includes sericite (5–80 percent), chlorite (5–70 percent), carbonates (1–15 percent), iron-ore minerals (2–10 percent), and quartz (5–30 percent) (0.02–0.04 mm). In parts contains scarce biotite flakes and tourmaline, and secondary carbonate minerals. Talc occurs along the contact with ore bodies. Dissolution of the pyrite occurs during exposure, creating the porous appearance (cavern porosity) and bleaching of the rock

Abm **Marble and dolostone**—Occur near ore bodies and contain carbonate-chlorite-sericite schists. On the contact with ore bodies these rocks contain large amounts of highly silicified pyrite, magnetite, and hematite impregnations. Rocks are gray and dark-gray, laminated, fine- to medium-grained, dense, and massive; are weakly reactive with HCl; contain carbonates (10–95 percent), quartz (3–75 percent), ore minerals (2–40 percent), and scarce sericite and barite

Kab Formation (Middle and Lower Paleozoic)—Occupies footwall of the Haji-Gak deposit. The thickness of the Kab Formation exceeds 1,200 m

Kbs **Sandy quartz-sericite schists (derived from acidic tuffs and tuffites)**—Dark-gray and gray, sand-like, thinly layered schistose rocks with relict psammitic, vitroclastic texture; contain subangular quartz (70 percent) (0.1–0.8 mm) and feldspar (30 percent), and cement mass from recrystallized fragments of glass, sericite, chlorite, iron hydroxides, and fine quartz grains. Is the most abundant rock type in the Kab Formation
Phyllites—Dark-gray and black, thinly layered schistose rocks with very fine grained lepidoblastic (in places relict pelitic) texture; contain sericite (35–70 percent), chlorite (as much as 10 percent), quartz (15–35 percent), coaly material (as much as 10 percent), iron-ore minerals, calcite, and iron hydroxides. Form thin interlayers in sandy quartz-sericite schists of the Kab Formation and derived from clayey material

INTRUSIVE COMPLEX

Diabase—Dark-green, fine- to medium-grained, massive rocks cut by quartz-hematite and carbonate veins. Larger bodies are 300 to 600 m long and 50 to 100 m thick; smaller bodies are less than 10 m long and 1 to 1.5 m thick. Unit composed of plagioclase (central part alters to saussurite and edges alter to albite) (30–60 percent), secondary minerals (hornblende (15–25 percent) and chlorite (10–25 percent)), and scarce zoisite, biotite, pyroxene, sphene, leucoxene, sericite, and iron-ore minerals. The grain size is 0.02 to 4.0 mm. Unit includes sills, dikes, and small stocks of diabase; occurs mostly among greenschists

sm **Semi-oxidized hydrogoethite-semi-martite ore**

gh **Semi-oxidized carbonate-semi-martite ore**

mm **Semi-oxidized hydrogoethite-hematite-semi-martite ore**

Non-oxidized pyrite-magnetite ore and carbonate-magnetite ore—Pattern shown in core holes only

EXPLANATION OF MAP SYMBOLS

Contact

80 **Fault or fracture**—Showing dip. Dashed where inferred; dotted where concealed

Folds—Showing trace of axial surface, direction of dip of limbs where known, and direction of plunge. Queried where uncertain

Syncline

Anticline

Strike and dip of bedding

40 Inclined

Vertical

35 **Strike and dip of schistosity**

12 **Trench-stripping site**—Number refers to trench-stripping log-data listed on p. 8 of Kusov and others (1965)

8 **Prospecting line**—Number refers to prospecting line log-data listed on p. 7 of Kusov and others (1965)

4 **Exploration shaft**—Number refers to exploration shaft log-data listed on p. 8 of Kusov and others (1965)

3 **Drill hole**—Number refers to drill hole log-data listed on p. 8 of Kusov and others (1965)

1 **Adit**—Number refers to adit log-data listed on p. 8 of Kusov and others (1965)

Hypothetical ore contact—Downdip extension may be greater than shown; in cross sections only

B **Boundary of fragmental ore deposit**—Letter identifies talus with ore fragments. In cross sections, boundary is labelled "detrital ore." Fragmental ore deposits are addressed in Reshetniak and Kusov (1965) and Kusov and others (1965)

60 **Brecciation zone**—Showing dip. Dotted where concealed

Road

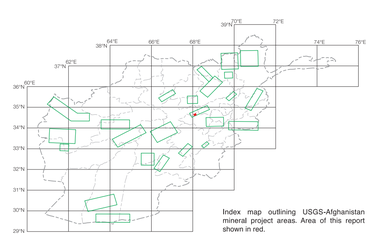
REFERENCES CITED

Ivanov, J., and Reshetniak, V.V., comps., 1965a, Geological log-data of drill holes nos. 1 and 3, Hajigak deposit, western area, *in* Kusov, I.K., Smirnov, M.S., and Reshetniak, V.V., Report of the results of prospecting-survey and reconnaissance works for iron ores in central Afghanistan with reserve calculation on Hajigak deposit for 1963–1964: Kabul, Ministry of Mines and Industries of the Royal Government of Afghanistan, report no. R0600, v. 3, draft no. 19, one sheet, scale 1:500. [Prepared by V/O Technoexport U.S.S.R. for the Ministry of Mines and Industries of the Royal Government of Afghanistan under contract no. 640.]

Ivanov, J., and Reshetniak, V.V., comps., 1965b, Geological log-data of drill holes nos. 2 and 4, Hajigak deposit, western area, *in* Kusov, I.K., Smirnov, M.S., and Reshetniak, V.V., Report of the results of prospecting-survey and reconnaissance works for iron ores in central Afghanistan with reserve calculation on Hajigak deposit for 1963–1964: Kabul, Ministry of Mines and Industries of the Royal Government of Afghanistan, report no. R0600, v. 3, draft no. 20, one sheet, scale 1:500. [Prepared by V/O Technoexport U.S.S.R. for the Ministry of Mines and Industries of the Royal Government of Afghanistan under contract no. 640.]

Kusov, I.K., Smirnov, M.S., and Reshetniak, V.V., 1965, Report of the results of prospecting-survey and reconnaissance works for iron ores in central Afghanistan with reserve calculation on Hajigak deposit for 1963–1964: Kabul, Ministry of Mines and Industries of the Royal Government of Afghanistan, report no. R0600, v. 1, report text, 156 p. [Prepared by V/O Technoexport U.S.S.R. for the Ministry of Mines and Industries of the Royal Government of Afghanistan under contract no. 640. Refer to p. 7–8, "List of graphical annexes for volume 3," for a listing of log data on trench-stripping sites, prospecting lines, exploration shafts, drill holes, and adits. These data all are contained in volume 3.]

Reshetniak, V.V., and Kusov, I.K., comps., 1965, Geologic-prospecting plan of western area of Hajigak iron-ore deposit, *in* Kusov, I.K., Smirnov, M.S., and Reshetniak, V.V., Report of the results of prospecting-survey and reconnaissance works for iron ores in central Afghanistan with reserve calculation on Hajigak deposit for 1963–1964: Kabul, Ministry of Mines and Industries of the Royal Government of Afghanistan, report no. R0600, v. 3, one sheet, scale 1:2,000. [Prepared by V/O Technoexport U.S.S.R. for the Ministry of Mines and Industries of the Royal Government of Afghanistan under contract no. 640.]



Index map outlining USGS-Afghanistan mineral project areas. Area of this report shown in red.

Geologic Map of the Western Haji-Gak Iron Deposit, Bamyan Province, Afghanistan, Modified From the 1965 Original Map Compilation of V.V. Reshetniak and I.K. Kusov

Compiled by

Karine M. Renaud, Robert D. Tucker, Stephen G. Peters, Will R. Stettner, Linda M. Masonic, and Thomas W. Moran

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