

## GEOLOGICAL MAP OF IRAN

### 1:100.000 SERIES

### SHEET 6951-DEHAJ

The southern and south-eastern parts of the Dehaj sheet represent monotonous area, with peaks over 3500 m high. The central and north-western parts belong to large dasht plain from which rise the impressive volcanic cones of Aj Bala and Aj Pain. In the northeast are spurs of the Kuh-e-Dari, with altitudes over 2000 m. The main water courses are the Rudkhaneh Miantal and Rudkhaneh Bidu in the north, and the Rudkhaneh Khabr and Rudkhaneh Trau in the south. The largest inhabited places are Dehaj, situated on the second-class Shahr-e-Babak – Yazd road, and the village of Khabr. A fairly dense network of motorable tracks connects Dehaj with neighbouring villages.

#### REVIEW OF FORMATIONS

The oldest deposits are lower Cretaceous sediments, appearing in the northeast of the sheet area. The age of the whole sequence is Neocombian-Aptian. The lowermost outcropping member of the Cretaceous sequence consists of well-bedded grey and yellow biomicrites. They contain a poorly preserved fauna, with indeterminate *Epistomina* sp., or *Lenticulina* sp., *Bolivinitidae*? *Tex-tularidae* or *Ophthalmididae*, rare *Permocalculus* sp., cf. *Boueina* sp., and others. These limestones are followed by a unit of grey and grayish-green siltstones, shales, and marls, with *Marsonella trochus*, *Orbitolinopsis* sp., *Dictioconus* cf. *wal-nutensis*, *D.* cf., *arabicus*, *Nautiloculina* cf. *oolitica*, *Orbitolina* cf. *discoidea*, these, *Orbitolina* cf. *discoidea*. These strata are conformably followed by grayish a unit of grey and grayish-green siltstones, sandstones, marls, oolitic limestones, and fluxoturbidites. These shallow water sediments display in places a fine lamination, large-scale cross-bedding, and ripple marks. In the oolitic limestones of this unit were found *Permocalculus* sp., *Dasycladacea* cf. *Nautiloculina* sp., *Lenticulina* (*Astaculus*) sp., *Lithocodium* sp., and cf. *Cylindroporella* sp.

The next unit corresponds to the sediments preliminary named in the Yazd sheet Taft formation (M.H. Nabavi pers. comm.). They are limestones and dolomites with *Marsonella trochus*, *Orbitolina* cf. *discoidea*. These strata are conformably followed by grayish and greenish siltstone, shales, and marls, which correspond to the sediments preliminarily named Dareh Zanjir formation in the Yazd sheet. Small brachiopods cf. *Musculina* sp., cf. *Sellithyris* sp., cf. *Orbirhynchia* sp., cf. *Cyclothyris* sp., cf. *Chlamis* sp., and echinoderms were found. *Orbitolina* limestone with dolomite, marl, and sandstone intercalations follows conformably. These sediments contain small *Miliolidae*, rare cf. *Valvulamina* sp., and *Textularia* sp., cf. *Orbitolinopsis* sp., and *Orbitolina* cf. *discoidea*.

Coloured Melange appears over a small area in the southwest, the groundmass of the Melange consists mostly of serpentinite, and in places marl and sandstone, which could also represent large complex olistolites (Kuh-e-Sabz). The olistolites consist of grey of pink thick-bedded limestone with a Senonian (mostly Campanian Maestrichtian) fauna, and serpentinite and chert. The serpentinite consists of antigorite and some bastite, together with accessory magnetite and chromite (gabbro dykes frequently invade these serpentinites). The melange is intruded by gabbroid and dioritic rocks. The anorthositic gabbro consists of basic plagioclases, fresh diagenesis with a thin amphibole rim, and magnetite. Diorite occurs with gabbro in the Chah-Talkh river. This rock is rich in mafic constituents and has a dark grey colour. It is composed of prismatic plagioclase crystals, partly unaltered mono-clinic pyroxene, and some chloritized biotite, accessories are magnetite and leucoxene.

Upper Cretaceous flysch forms a thin belt southeast of Kuh-e-Siah. It is composed of an alternation of thin calcarenite and marl beds. Sedimentary structures are not common, they are mostly small-scale flute casts. In the upper levels of this unit turbidites gradually disappear, and finely laminated marls prevail. In the calcarenites were found *Heterohelix* sp., *Hedbergella* sp., *Oligosteginidae*, *Pithonella ovalis*, *Stomiosphaera* sp., and others. The thickness of the outcropping part amounts to 200 m.

Eocene flysch occurs over a small area south of Kuh-e-Talkh, as tectonic wedges in the Colored Melange. It consists of sandstones and marls, showing large but not abundant flute casts and drag marks, small-scale graded bedding, and lamination. Upper surfaces of beds show in places poorly developed ripple marks. These rocks contain cf. *Globorotalia* sp., cf. *Globorotalina* sp., cf. *Bolivina* sp., and *Nummulites* var. sp. of probable Lower Eocene age. The outcropping part is about 180 m thick.

The volcanic Eocene complex can be divided into two subcomplexes, with a total thickness of about 1500 m.

The lower subcomplex consists mostly of andesite, andesite-basalt, trachyandesite, and trachybasalt pyroclastics and lava flows, and is almost devoid of sedimentary rocks. The most widespread rocks are andesite-basalts, of a brown-red, in places almost black, colour. They are holocrystalline-porphyrific in

texture and composed of phenol-crysts of plagioclase and monoclinic pyroxene (in places also olivine) in a groundmass with microlites of plagioclase, fine augite grains, and profuse Fe-oxide. Trachyandesite-basalt differ from these rocks only in containing K-feldspar and rhombic pyroxene. Basalts are uncommon. They are characterized by oligophyric texture, scarce phenocryst of monoclinic pyroxene and plagioclase, and subordinate olivine. Trachyandesites are also common. They exhibit hydrothermal alteration and contain a very small quantity of mafic constituents (mostly biotite).

The upper subcomplex is predominantly pyroclastic. Its most conspicuous are red and reddish-brown Andesite tuffs, followed by green tuffaceous sandstones and andesitic tuffs of the middle horizons and red tuffaceous, sandstones, quartz sandstones, and limestone beds of the upper horizons. Andesite-basalts are the most common rocks, having essentially the same character as those in the lower subcomplex. The uppermost levels are injected by phonolite-type rocks east of Gaz Baland village. These rocks have a conspicuous porphyritic texture, with phenocrysts and irregular grains of analcime up to 4 cm in diameter. Other phenocrysts consist of plagioclase, K-feldspar, olivine, and monoclinic pyroxene. The groundmass is of microlites of K-feldspar, with plagioclase, augite, leucite, analcime, nepheline, and profuse limonitic-hematitic matter. The feldspathoid content varies between negligible quantities and 15%. Analcime is always present, even amounting to more than 20%.

Diorite-porphyrite and quartzdiorite-porphyrite form the order Eocene and younger Neogene, igneous rocks. They consist of completely altered plagioclases, destroyed mafic constituents (ghosts of which are filled with chlorite and Fe-oxide) and in places xenomorphic quartz grains. The microgranular holocrystalline groundmass contains microlites of altered plagioclases, some quartz, and profuse secondary products.

Granodiorite occurs over a small area in the eastern part of the sheet, intruding the Eocene rocks. It is a massive medium-grained rock, light grey in colour, and consists of subhedral plagioclase crystals, partly perthitized K-feldspar, quartz, hornblende, and rare biotite and uranitized monoclinic pyroxene. Zircon, apatite, and magnetite are accessory.

The lower red formation appears south of Kuh-e-Karadan and around Kuh-e-Zamzu. It is composed of red shales and sandstones. The shales are poorly bedded and contain some tuff component. Sandstones form thick beds; they display frequently a well-developed lamination. And in places also large-scale cross-bedding. Higher levels of this formation have thin intercalations of gypsum. No fauna was found in this unit, the thickness of which is more than 250 m.

The Qom formation follows conformably. This is a unit, 80 m thick composed of limestone layers with intercalations of grey weathered marls. Some of the limestone beds contain small bodies of brown chert. The lower Miocene age of this formation was proved by algae *Cymopolia* sp. *halmiedae*, cf. *Munieria* sp., cf. *Mesophyllum* sp., Charophyta oogonia, and ostracods.

The upper red formation follows conformably. It is represented by red tuffaceous argillaceous rocks, grey quartz, sandstones with carbonate and tuffaceous binder, and conglomerates. In the argillaceous strata pure gypsum veins are common. The argillaceous and tuffaceous deposits are more characteristic of the lower parts of the unit, the upper parts being sandier and more conglomeratic. At Kuh-e-Zamzu thick beds of well-indurated breccia also occur. The thickness of the outcropping part is about 200 m.

Neogene sediments occur as a large belt around the southern mountains area.

The lowermost Neogene unit is composed of arenites with boulders of Eocene volcanics. The arenites are light grey, mostly not well-indurated, and without fossils. The lower part of this unit contains many boulders and has the appearance of a coarse conglomerate with sandy binder. The boulders are poorly rounded and chaotically scattered. The upper part of the unit is composed of arenites, with subordinate well-rounded blocks, with diameters under 70 cm. The unit is 450 m thick. Grey and greenish-grey, poorly consolidated arenites follow, in thick layers with weakly expressed lamination. In places there are also beds and lenses of conglomerates, composed of well-rounded pebbles not larger than 5 cm. In this unit, also are thin but laterally persistent layers of yellow sandy clay, with sharp boundaries toward the floor and the roof. The thickness of this unit is about 500 m. The next unit consists also of poorly lithified light-colored sandstone and conglomerate in about equal quantities. The conglomerate forms thick layers and consist of rather well-rounded pebbles up to 10 cm in diameter. Some of the conglomerate beds display a very conspicuous imbricate structure. The thickness of this unit is 550 m. The uppermost unit of the sequence is an argillaceous boulder conglomerate with some sandstone. The sorting of the conglomerates is poor, and the pebbles have a variable roundness; large single boulders occur in places. This unit contains a horizon, 20 m thick, of sandy clay identical in appearance with the clay horizon in the lower unit Ngs1. The thickness of the unit is 650 m.

The youngest Neogene sediments, believed to be of Plio-Pleistocene age, follow unconformably. They were deposited in a shallow basin during volcanic activity. The unit begins with 0.5 m of basal conglomerate with tuffaceous binder, followed by 3-5 m of dacitoandesitic tuffs, reddish-violet to

brown in colour. they grade upwards into grey and yellow sandstones and conglomerates, with argillaceous and tuffaceous binder. sandstone layers commonly show conspicuous graded bedding and horizontal lamination. the conglomerates are poorly sorted and contain pebbles of variable roundness. the unit contains small lenses of grayish-brown, well cemented dacitic andesitic tuffs. the thickness of this unit is about 300 m.

during the deposition of the? plio- Pleistocene sediments there was marked volcanic activity, which probably began slightly before, and lasted possibly even after, sedimentation. the oldest phases of this activity are represented by dacitic- andesites and hyaloandesites, which form a number of plugs scattered throughout the southern and central parts of the sheet area. the dacite-andesites are mostly hornblende-biotite phenoandesites and dacites of por-phyritic texture. with pliotaxitic and micropoikilitic groundmass. plagioclases are andesine, hornblende is only slightly opacitized, biotite is fresh; large quartz phenocrysts, though not common, are visible in hand specimen. the groundmass contains feldspar microlites, rare grains of mafic constituents, and fe-oxide, the hyaloandesites are grey-violet to almost black rocks with a generally vitreous appearance and conspicuous porphyritic structure. they contain clear zonal plagioclase, basaltic hornblende, and very subordinate biotite and monoclinic pyroxene.all very fresh. the groundmass is vitreous, less frequently hypocrySTALLINE or cryptocrySTALLINE, and contains micro lites of plagioclase and mafic constituents.

Youngest phases of this volcanism are represented by the andesites of aj pain and aj bala. these rocks are grey in colour and have a weakly expressed prophyritic texture. they consist of plagioclase phenocrysts, basaltic horn blend, very variable quantities of biotite, and subordinate crystals of augite and quartz. the groundmass is micropoikilitic, with plagioclase, quartz, mafic constituents, and some carbonate, hornblendes is completely opacitized and appears in places only as ghosts filled with magnetite and some augite. Biotite and augite are always fresh, as are most of the plagioclase crystals.

The plio-pleistocene sediments are topped by a black basalt laval flow of wide extent. the basalt consists of olivine phenocrysts, less frequently monoclinic pyroxene and plagioclase, in a microcrystalline groundmass containing microlites of monoclinic pyroxene and plagioclase, and some glass, Quaternary deposits cover a vast area in the north. Older dasht is preserved over a small area. Younger dasht covers large plains, having a composition depending very much on the rocks prevailing in the source area. Gravel fans are very conspicuous around the aj pain and aj bala as also around lone peaks consisting of cretaceous limestone. Talus cones cover the flanks of highstanding peaks; the constituenths of the talus are in places cemented by calcareous binder. A part of the northern plains is covered by sand, with dunes up to 1 km long.

## STRUCTURAL FEATURES

The most conspicuous feature in the sheet area is the large anticline of Kediri and Dehaj in the southern part of the sheet area, flanked by periclinally dipping Neogene sediments. The structure of this feature is rather complex. Its central part forms a broad syncline featured by younger transverse and longitudinal faults. The general arching of this area was a young Neogene to pleistocene event, and could have been partly contemporaneous with sedimentation of strata of this age.

The south-western margin of this block is delineated by a discontinuous fault, which separates this area from the kuh-e-sabz zone of Coloured Melange.

The northern part of the area (kuh-e-Dari block) is virtually a gently folded plate, locally deformed by longitudinal faults.