

GEOLOGICAL MAP OF IRAN

1:100.000 SERIES

SHEET 7954- SAHLABAD

The sheet area is in the Khorassan Province of eastern Iran, southeast of the town of Birjand. It covers the eastern parts of the South Birjand and Kuh-e-Shah Ranges, here carrying the names Kuh-e-Ateshkadeh/Kuh-e-Chehel Dokhtar and Kuh-e-Zar/Kuh-e-Bazu respectively. These ranges branch northwesterly from the north-south trending main system of the East Iranian Ranges that pass a short distance east of the sheet boundary.

Minor parts of adjoining branches are also included--- the Mahallabad hills in the southwest corner, which belong to the Barak-Basiran branch, and the mountains of Zangiabad in the northeast corner, which are close to the main trunk of the East Iranian Ranges. The southeast-northwest trending branch ranges are separated by the large valley plains of Rudkhaneh-e-Tag and Rudkhaneh-e-Sartak.

The Namakzar-e-Sahlabad (salt lake) occupies the southeast part. The latter, with an altitude of 1335m, represents the lowest part of the area, the highest point is Kuh-3-Bazu, with an altitude of 2352m. The climate is semi-desertic, ameliorated by the relatively high mean altitude. Precipitation is sufficient to allow a modest oasisment of groundwater resources. Cattle breeding, however, is the main occupation of the population. The main Birjand-Zahedan gravel road crosses the area from north to south. There are several villages, mainly in the valleys of Kuh-e-Zar and along the main road, the two largest ones, Sahlabad and Fereydoun, have each about 300 families. Most of the settlements are connected by motorable tracks with the Birjand-Zahedan road.

REVIEW OF FORMATIONS

The area lies entirely within the "Flysch and Coloured Melange Belt" of East Iran. The exposed formations comprise the rocks characteristic of this belt, which are attributed to the Upper Cretaceous and Lower Tertiary, and their younger Tertiary volcanic and sedimentary cover.

Typical Melange complexes are widely exposed in Kuh-e-Ateshkadeh and Kuh-e-Kheiry, and also in the Mahlabad hills in the southwest and in the Zangiabad Mountains in the northeast. They appear as lithologically complex and structurally highly disturbed associations of ultrabasic and basic rocks with various sedimentary and metamorphic material.

The ultrabasics (ub) form several extensive exposures in Kuh-e-Ateshkadeh, where they consist largely of dunite (du) and serpentinite (sr), less frequently of pyroxenite (px). Closely associated with them are lens-shaped or irregular bodies of listvinite (ophicarbonates) (lv) displaying characteristic yellow, orange and reddish colours. Diabases (k^u_d) also form several extensive, rather homogeneous masses but, unlike the ultrabasics, which usually show tectonic contacts with other rocks, they display in many places a clear synsedimentary association with Upper Cretaceous limestone and other marine deposits. Porphyritic gabbro (gb) occurs in a few outcrops, in the more typical small-scale mélanges (cm) such as are found, e.g., in the area of Golandam blocks of ultrabasic and basic rocks of all size appear chaotically intermingled with the sedimentary material.

The sedimentary components of the Melanges in this area consist mainly of rather massive, dense to fine-grained limestone (k^u_l) of pinkish colour, and of subordinate greenish shale and tuffaceous rocks (k^u_{ct}). The limestone is best exposed in Kuh-e-Ateshkadeh, where it forms several thick, elongated, contorted bodies that show normal, synsedimentary contacts with diabase, diabasic tuff and tuffaceous conglomerate. At a place 2 km north-northeast of Shirshotor the limestone has yielded *Hedbergella* sp & *Globotruncana* sp. A similar limestone forms a thin intercalation in bedded diabase on the Birjand-Zahedan road, 5 km west-northwest of Koharud. A tectonic lense of pinkish limestone with *Pithonella ovalis*, *Stomiosphaera sphaerica* and *Calcisphaerula innominata* is found within the ultrabasic mass 4 km southeast of Dastgerd, and a small limestone block in the Melange at Golandam has yielded *Globotruncana lapparenti*, *G. arca*, *G. coronata*, *pithonella ovalis*, *Stomiosphaera sphaerica* and *Calcisphaerula innominata*. These microfossils indicate Late Cretaceous, essentially Senonian, age. No older fossils are known from this area.

On the north side of Kuh-e-Ateshkadeh, east of the main road, the Melange shows distinct metamorphism (met). Rocks include metadiabase (mtd), albite-sericite schist (sch), biotite gneiss (gn), amphibolite and amphibolite schist (am), strongly recrystallized listvinite, and largely serpentinitized ultrabasic rocks. Metamorphic rocks of similar description constitute also most of the Melange in the southwest corner of the area. While many of these rocks can be identified as metamorphosed equivalents of the various rock types characterizing the non-metamorphic Melange, some may also represent exotic blocks or tectonic slices derived from outside the Melange and Flysch Belt.

At several localities small erosional rills of little disturbed nummulitic limestone (En) rest transgressively and with sharp unconformity on various parts of the Melange complexes.

The flysch-type sequences, best exposed in Kuh-e-Zar and in the northeastern hills (Zangiabad) include both Late Cretaceous and Early Tertiary deposits. Those of Kuh-e-Zar consist mainly of green-grey phyllitized shale (K_{ph}^u), in part slightly calcareous, with bands of sandstone and subordinate intercalations of diabase (K_d^u), diabasic tuff, radiolarite (k_r^u), radiolarian shale, and occasional lenticular interbeds of dense pinkish limestone (K^u) containing Late Cretaceous globotruncanids. Thin bands of marmorized limestone (mb) occur in the more phyllitized shales. The shales are tightly folded, so that their original thickness could not be measured, it is estimated to be at least 2000 m.

A similar flysch-like shaly succession (Pgf), but less intensely folded and with only minor volcanic material of andesitic composition (Pga) in the lower part exposed, occurs in the mountains west of Zangiabad in the northeast of the area. In their immediate northwestern continuation in the area of the Sarbisheh sheet these have yielded microfossils (mainly nummulites) of Paleocene-Early Eocene age, this Lower Tertiary Flysch seems to develop laterally from thick, nummulite-bearing limestones and marls which are widely distributed further northwest, in the northern Birjand area. And there overlie the Cretaceous Melange and Flysch complexes with pronounced unconformity.

These limestones and marls of the northern Birjand area clearly mark the western marginal zone of Early Tertiary marine deposition in this part of Iran, whereas the shales of the Zangiabad mountains apparently represent a deeper part of the marine trough, where flysch-type deposition continued, perhaps uninterruptedly, from Late Cretaceous to Early Tertiary. The distinction between the Cretaceous and Tertiary portions of the Flysch succession is difficult on lithological grounds only. On this map it is based on sparse and widely scattered fossil evidence. And more detailed studies in the future may necessitate considerable correction.

The phyllitized shales (Pgph) south of Khosrowabad-Baghestan have also been tentatively attributed to the lower Tertiary, because scarce Early-middle Eocene nummulites have been found in their southern continuation (Chahar Farsakh sheet), and because they seem to correlate with lower parts of the sandy-marly and tuffaceous Eocene succession of Kuh-e-Bazu. However, the lack of fossils make a definite attribution of the entire phyllite section to the lower Tertiary uncertain; parts may be Upper Cretaceous.

The Eocene Sequence of Kuh-e-Bazu shows an alternation of green-grey marly shale and sandstone (Ems) including some lenses of dark-grey, sandy, calcite-veined limestone (En) that contains Nummulites globulus, Assilina sp., Discocyclina sp., Rotalia sp., and Cuvillierina sp., suggesting an Early-Middle Eocene age. Numerous acidic dykes, mainly dacite, pierce the sediments.

Thick Tertiary volcanic rocks underlain by Lower Eocene sediments form the hills of Kuh-d-Sara and their southeastern continuation. The section starts with a conglomerate (Ec) that overlies unconformably the Cretaceous Flysch near Fereydoun. The conglomerate grades upwards into greenish marls and sandstone (Ems.) these rocks contain Globorotalia aragonensis and Globigerina sp., and are topped by a thick lenticular bed of grey limestone (En) with Nummulites sp., Coskinolina-Pithonella sp., Saudia sp., Miscellanea sp., Glomalveolina sp., Alveolina schwageri and orbitolites complanatus, these basal sediments of the Tertiary sequence are 300-400m thick and seem again to correlate partly with the marly-sandy succession of Kuh-e-Bazu (Ems). Above follow conformably many hundred meters of volcanic and pyroclastic rocks comprising dacitic tuff breccias (EOB), strongly altered marly tuff (EOt), and andesite lavas (EOa). They are still rather strongly folded and are overlapped with distinct unconformity by a thick, subhorizontal flow of pyroxene-olivine basalt (b) which is thought to be Neogene and possibly as young as Quaternary.

Intensely red and green-coloured tuffs (EOt) of Paleogene (?) age overlie unconformably the Paleocene Lower Eocene Flysch of Zangiabad in the northeast.

In Kuh-e-Chehel Dokhtar in the northwestern part of the area, the Tertiary succession starts again with fossiliferous sedimentary deposits, which comprise sandstones and marls (Ems) in the lower part and massive limestone (En) in the upper part. These beds rest with sharp unconformity on ultrabasic and other rocks of the Cretaceous Melange. The fauna of the sandy lower beds includes Alveolina sp. and Discocyclina sp., that of the calcareous upper part Nummulites globulus, N. aturicus?, Assilina sp., and Discocyclina sp., Neogene pyroxene basalt (b), which overlaps unconformably these nummulite-bearing beds as well as the Melange complex to the southwest, possibly reaches even into the Quaternary. Northeast of Kuh-e-Chehel Dokhtar, similar pyroxene basalt overlies unconformably a widespread unit of pyroxene andesite (ap).

The basalt of Kuh-d-Chehel Dokhtar is definitely younger than a thick, gently folded group of variegated marly and conglomeratic tuffs (Ngt), gypsiferous red beds (Ngm), and conglomerates with marls (Ngcm), which from their unconformable overlap on the "Paleogene" volcanics are attributed to the "Neogene" these predominant sedimentary Upper Tertiary deposits, which also include some

unfossiliferous porous limestone (Ng) of probably fresh-water origin, fill the depressions between the main mountain ranges.

Unfolded Quaternary deposits are represented mainly by extensive gravel fans (Qt2), in which locally, near the foot of the mountains, some terrace-forming older parts (Qt1) can be distinguished. Salt and salt mud fill the depression of Namakzar-e-Sahlabad and a few smaller depressions in the valleys of Rudkhaneh-e-Tag and Rudkhaneh-e-Sartak. Minor accumulations of Aeolian sand are found at the northwestern margin of Namakzar-e-Sahlabad.

STRUCTURE

The area belongs to the "Flysch and Coloured Melange Belt" of eastern Iran, east of the Lut Block. The general trend turns from S-N (the main trend of the belt, visible in the extreme northeast of the map) into the southeast-northwest trend which dominates this area and reflects a regional bend of the Flysch-and-Melange Belt around the Shahkuh bulge of the Lut Block (southwest of the sheet boundary), the tight folding of the Flysch deposits and the chaotic structure of the Melange complexes indicate intense compression. Crustal deformation was strongest in the southwestern extremity of the area, where a narrow zone of imbrication, thrusting and metamorphism (metamorphic Melange) marks the nearby junction of the extremely mobile Flysch-and-Melange Belt with the rigid Lut Block. Here vergence is clearly to the NE, but it varies in the rest of the area.

Contorted folding and crushing that resulted in a random intermingling of the various rock types characterizes also the Melange complexes of Kuh-e-Ateshkadeh. From the age of the youngest datable rocks involved (Upper Cretaceous limestone) and of the oldest cover rocks (nummulitic limestones), the compressional movements which created the Melanges of this area can be dated as latest Cretaceous to earliest Tertiary.

Less intense but still narrow folding, longitudinal faulting and thrusting of post-Middle Eocene (Oligocene) age affected the Paleogene sedimentary and volcanic formation, the Cretaceous Flysch of Kuh-e-Zar as a whole is thrust southwestwards on the Eocene sediments of Kuh-e-Bazu. The same movements also created the system of parallel mountain ranges and intervening depressions that characterizes the present topography. The Neogene sedimentary fill of the depressions was subjected to moderate folding and minor faulting. The andesites and basalts representing the youngest (Neogene, possibly Early Quaternary) volcanics show gentle tilting (with dips not exceeding 20°) in the lower units and subhorizontal position in the upper ones. A youngest system of important N-S faults, affecting even Quaternary alluvium is clearly recognizable (Esmailabad fault).

MINERAL INDICATIONS

Small ancient workings with indications of malachite are found in Cretaceous diabase near the Birjand-Zahedan road, east and west of Koharud. Vein-type mineralizations showing malachite and chrysocolla occur in Paleogene andsite 3 km west of Tutesk.

Spectrographic analysis of two samples of listvinite exposed on the Birjand-Zahedan road, 5 km north of Sahabad have shown distinct traces of Gold. The listvinite displays under the microscope a mesh structure, possibly inherited from serpentine. The main constituent minerals are: carbonates (dolomite and calcite) pseudomorphic after olivine or pyroxene, quartz filling small fissures and forming aggregates, serpentine and chlorite as alteration products of mafic minerals, and accessory iron oxide, spinel, and other opaque minerals.

Magnesite is exploited from deposits in serpentinite at Noghab and, in smaller quantities, 5 km east of Mazar.

Rock salt is collected for local use from Namakzar-e-Sahlabad.