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GEOLOGICAL MAP OF IRAN
1:100.000 SERIES
SHEET 7948 – KAHURAK

The sheet area is located along the southeastern edge of the Lut desert and its eastern margin, including a portion of the elongate NNW-trending range of mountains near Kuh-e Kalat.
The mountains are drained to the west by the Rudkhaneh-ye Gorg, Rud-e Shureh Gaz and Rud-e-Mahi, all of which empty into the closed basins of the southeastern Lut area. The only access into the area is by the Bam-Zahedan highway which crosses the NW corner of the sheet. The small settlements of Kahurak and Gorg are located on or near the highway where it crosses the Rudkhaneh-ye Gorg.
Parallel elongate outcrops of NNW-trending Late Mesozoic and Paleogene igneous and marine clastics, and Neogene continental clastics form the mountain chain along the eastern boundary of the sheet. A central deformed belt of Neogene red-beds and layered Paleogene volcanics separates the mountain belt from the relatively stable, undeformed platform of mantled Neogene continental clastics in the western one-third of the sheet. Tectonically, the area is controlled by a very young family of N to NNW-trending right-lateral strike-slip or wrench faults which have created large anticlines in the central deformed belt. The elongate exposured of older rocks along the eastern map margin are related to a series of older imbricate thrust sheets.

REVIEW OF FORMATIONS

Late Cretaceous or older basic igneous rocks comprise the dismembered ophiolitic sequence found along Kuh-e Dar-rahdan in the NE corner of the sheet. Layered gabbros with minor quartz diorite differentiates make up the lower part of the sequence; dark, mafic-rich zones are found with thinner, Iess voluminous zones of mafic-poor leucocratic gabbro's. Diabases and spilitic lavas with red radiolarian chert beds form the upper parts of the sequence. Low-grade greenschist metamorphism has produced epidote and chlorite, creating greenstones from the spilites. Based on rock facies containing the red radiolarian cherts, the formation has been tentatively placed in the Upper Cretaceous, possibly Maestrichtian. The formation has been tectonically emplaced along a series of high angle thrust faults which have dismembered the ophiolites; the sheared and granulated fabric of the rocks and the presence of sheared serpentinitc along the thrust planes reveals the mode of emplacement.
Intimately associated with the ophiolitic igneous rocks are extremely tectonized thrust sheets of turbiditic greenish-grey sandstones and pale green shales that have undergone extreme cataclastic dcformation. Bedding has been disrupted completely in many areas and a tectonic fabric has replaced the original sedimentary texture. The more resistant sandstone units have been reformed into a series of shear phaccolds or lenticular bodies oriented semi-parallel to the original bedding and in the direction of the thrusting. creating in places a sedimentary melange. Shales have been changed into platy phyllonites that resemble phyllites, and fractures perpendicular to the bedding/foliation have calcite fillings. Where shearing has been less intense, turbidite layering can still be observed. Recrystallised limestones are also found in the sheard meta-flysch. The limestones have been rolled about during tectonism and occur as discrete blocks; they could be resistant blocks that were originally limestone beds in the flysch, or they could be sedimentary inclusions that were carried downslope during turbidite deposition. Shearing in the flysch has been parallel to the bedding. No fossils have been found in the metaflysch or marbles and no definite age has been assigned to them; their association with the ophiolitic rocks would appear to place them as some - what younger than the igneous rocks. They are in tectonic contact with the unmetamorphosed bedding Eocene turbidites to the west.
The imbricate thrust sheets of the ophiolitic rocks and meta-turbidites probably represent old oceanic crust and its overlying deep-marine sedimentary cover. These have been stacked against the thrust under similar older sequences to the east. The prevalence of cataclasis and the occurrence of sheared serpentinite along the base of the thrust plate's points to the profound faulting that has juxtaposed the formations, indeed, both units may be parts of a larger tectonic unit that has been described elsewhere in Iran, the Coloured Melange. A sequence of clastic sediments of definite Paleogene age occurs along the eastern margin of the sheet immediately west of the meta-flysch and ophiolites. Within this may be recognized two main units. The lower unit consists of upwards of 1.000 m of thinly bedded alternating layers of fossiliferous grey sandstones and pale green shales. The sandstones are medium to fine-grained lithic
Sandstones containing abundant, well packed volcanic fragments. The presence of a shallow marine fauna interbedded with deep marine shales, flute casts, and graded bedding is interpreted as representing a turbidite sequence. The formation is given an Early to Middle Eocene age based on the

identification of Elphidium sp., Nonion sp, Discocyclina douvellei, Nummulites sp., Anomalina sp., Amphistegins sp, and opcrrulina sp., Rotalia sp,miliolids, ostracods and algae are also present. Near the top of the formation, volcanic arenites become more abundant and a number of thick dykes or hornblende andesite porphyry occur semi-concordant or completely discordant to the bedding within the turbidites, south of Rud-e Mahi. Directly overlying the Eocene turbidites, in a very slightly unconformable or disconformable contact, is a volcanic arenile sequence to which an Oligocene-Miocene age has been attributed. This formation called the kungi, conglomerate com posed of thick, pale red-purple coarse grained clastics with a basal zone of massive conglomerate having a coarse sand matrix. The conglomerate is mainly volcanic in nature, but cobbles of having a coarse sand matrix. The conglomerate is mainly volcanic in nature, but cobbles of nummulites-bearing sandstones are also present; all cobbles are well rounded. Upwards, the grain size tends to decrease, conglomerates becoming less massive with smaller clasts, sands becoming predominant and fine-grained silty sandstones beginning to occur. This unit is oxidized and has calcareous cement. The nummulitc-bearing sandstone clasts and the volcanic debris was eroded and deposited in a shallow marinc basin which was then exposed to subaerial conditions. Deposition began after the end of the turbidite formation and took place in a serics of rather rapid influxes. Upwards of 500m of conglomerate and sandstonc are exposed with the unit being faulted out against a volcanic formation to the west. Both the Eocene turbidites and the volcanic arenites are highly faulted and folded.

Volcanics of Oligocene and probable Oligocene age are exposed in two main areas. Along the eastern map border, a NNW-trending belt of Eocene volcanics and sediments runs through the entire length of the sheet and is faulted on the cast against both the Eocene turbidites and the volcanic arenites. The best exposures are located in the SE corner of the map and consist of intercalations of vitric and lapilli tuffs, reddish-purple volcanic conglomerates, basalt and basaltic andesite lavas, volcanic arenites, silicious micrites, and a thin coral bed. Nummuiles fichteli, Nummulites intermedius, Gypsina sp., Aktinocyclina sp., Archaias. sp and miliolids are present in various beds and indicate an Oligocene age for the unit. Upwards of 1500 m or bedding arc exposed before the unit is faulted out to the west against Neogene red-beds, or else is unconformably overlain by younger conglomerates. This unit becomes more scdimentary in nature towards the top and appears to be overlain by Neogene clastics where the contact is not faulted. The second main area of volcanics of probable Oligocene age occurs around Kuh-e Mazareb in the centre of the sheet. These volcanics arc a faultbounded wedge of thick vitric turf beds, massive volcanic breccia's, and thin lava flows of olivine basalt and olivine andesite. These three types of beds form repetitive sequences and may represent a fossil volcanic centre; alternatively, they may be interbedded layers in the arched core of a large anticline. Farther to the south of Kuh-e Mazareb, across Rud-e Shureh Gaz, the eroded core of a smaller anticline exposes massive pale yellow and pale green tuffs that bocome progressively interbedded in the early Neogene red-beds on the outer limbs of the structure. It is conceivable that the volcanics may underlie the red-beds where no turbidites are found, i.e. on the Lut Block.

In the western two-thirds of the map area, at Ieast 1,000 m of Neogene red-beds are found to occur. These clastics have either a tan or a distinctly reddish hue and the lower units have thin gypsum interbeds and gypsiferous red marls. Sandy units arc fine to medium-grained, volcanic lithic arenites with calcareous cement containing reworked Eocene foraminifera. A few lithic fragments of metamorphic origin are also present and could be derived from the meta-flysch formation to the cast. Passing upwards, the unit loses its red colour, gypsum disappears, and tan sandy siltstones become more important. The formation passes into or is overlain by (depending upon the degree of deformation in the red-beds) a younger (? Pliocene) conglomerate capping. Lower beds have numerous fractures or faults that are filled with gypsum. No limestones or green marls have been found in the red-beds, nor have any in situ fossils been identified; however, the formation is probably correlative with the Upper Red Formation described in other parts of Iran.

The Neogene red-beds are capped by a massive unconsolidated conglomerate of questionable Pliocene age, composed of sub-rounded to rounded volcanic and sedimentary clasts. This formation has been warped by the large anticlinal features seen in the area. Where Neogene beds are flat-lying or recently deformed, the conglomerate cap is in conformable contact with it; where the Neogene has been greatly disturbed during older tectonic movements such as along the contact with the Oligocene volcanics to the cast, the contact is unconformable. A vertebrate jawbone with several teeth was found imbedded in this conglomerate, but no age has yet been determined for it.

Quaternary deposits are represented by several types of units. Two generations of fans are present; an older, deeply dissected fan set is found on slopes leading from mountainous areas. This older fan type is relatively stable and is usually much darker than the younger fans. The darker coloration is due to sun-varnish on exposed cobbles, cobbles in younger fans are more mobile and are constantly overturned so that no single face of the stones is exposed to the sun. Younger fans may grade from the

older fans and are usually found in areas where the gradient is much reduced. These fans are lower and less deeply dissected than the older fans. Their semi-mobile nature gives them a lighter coloration. Terraces of alluvium are present in several areas, most notably overlying Neogene exposures in the SW corner of the map. Lage areas of dune sands are located in the southern and central low-lying areas; both active young dune fields and older, stabilised dunes with vegetation are present. To the northwest, erosion reworking of the sheet wash that overlie the flat-lying Neogene clasties, aided by wind transport, has created a dasht or desert pavement of gravel with localised sand fields. Also, internal drainage has led to the formation of salt playas and salt marshes in the central and north-western sections of the map.

INTRUSIVE ROCKS

Intrusive rocks are poorly represented in the sheet. Small leucocratic intermediate-composition differentiates are found scattered about in the basic ophiolitic rocks and are related to them. Two very small outcrops of biotite microdiorite occur in the Oligocene tuffs and lavas of Kuh-e Mazareb. These microdiorites may be parts of feeder vents for the overlying volcanics. One small dyke of quartz diabase is also exposed in this same area. Within the ophiolitic zones, basic igneous sequences including the underlying intrusive equivalents are found.

STRUCTURE AND TECTONICS

The sheet covers the structural boundary between the stable, relatively undeformed, young Neogene rocks on the west and the shared, steeply-dipping, sequence of overthrust older rocks on the east. Three tectonic provinces can thus be defined in the sheet. The youngest tectonic province is the central boundary zone, a broad area of shear dominated by very recent right-lateral wrench faulting. Strike-slip movement has taken place along a series of related faults that splay off the main NNE -trending Kahurak master wrench fault. This wrenching was warped the border zone and produced a series of "en echelon" right-handed folds in the Neogene red-beds. Small normal tension faults have developed between the main wrench faults, as have smaller folds and possible conjugate wrench faults. The amount of displacement along the fault is not known since no key units have been found along either side of the faults; offset along any one of the main faults is not thought to be great due to the youthful configuration of the fault system-total accumulative lateral movement is probably somewhat greater than that along any one fault. The age of the last movement along the wrench system is quite young scarps and fault traces across Quaternary playas and fans suggest the wrenching is still active. Wrenching is certainly much younger than the thrusting found to the east; the NNE strike of the Kahurak fault suggests it cuts the NNW trend of the thrusts farther to the north toward Nosratabad. To the west of the Kahurak fault lies the Lut stable zone. The Neogene clastics of this area are deformed only in the immediate vicinity of the Kahurak fault trace. The Neogene rocks there dip gently away from the shear zone (probably due to a slight convergence between the interacting blocks which has resulted in compressional bulging along the fault) until they assume a horizontal attitude. East of the zone of wrenching lies the zone of earlier thrusting. All rock contacts here are NNW-trending thrust faults, dipping steeply (75 to 85°) eastwards. These rocks have been stacked up, forming an obducted series of imbricate sheets in the suture zone.

Sheared serpentinite along the base of some of the thrusts attests to the profound tectonism that has resulted in the formation of this imbricate thrust-fault sequence. West of the master thrust-fault (located between the sheared meta-flysch and ophiolitic rocks on the east and the Eocene turbidites on the west) the youngest turbidite sequence has been folded or rolled into a long, narrow series of anticlinal and synclinal folds that parallel the fault traces. NE-trending normal faults have developed across the folds in response to tensional stresses.

On a regional scale, the thrust sequence most probably represents a compressional suture zone that closed a narrow ocean basin, convergence and subduction creating the series of imbricate thrust sheets of deep marine turbidites, ophiolitic rocks, and sheared serpentinites. Cessation underthrusting was followed by a period of uplift as the suture healed, forming the present-da linear mountain range with its definite zonation of rock units. Formation of the younger strike-slip family of faults began after suturing, due to continued oblique convergence directed from the WSW between the blocks involved. Continued uplift or deformation along the border zone resulting in the formation of the young (?) Pliocene conglomerates that now overlie the Neogene red-beds.

ECONOMIC GEOLOGY

Mineral occurrences are few and confined to two general areas. The Shoveh copper occurrence is located in the NE corner of the map sheet and exhibits propylitised porphyry andesite's with stockwork veins of quartz-calcite-epidote containing copper carbonates, chalcoci native copper, and minor pyrite. Southwards from this occurrence, traces of malachite and azurite stain in fracture fillings were found in the andesite's and volcanic conglomerates. Gypsum is found over a large area (approximately 20 km^2) of the SW corner of the map, south of Rud-e Shureh Gaz. Folded Neogene red-beds there contain thin (1-2 cm) interbedded layers of gypsum up to 1m thick is also found as fracture or fault fillings.