2.2.2. Geology

The geological map, which focuses on Cenozoic sediments in the Tehran region, was prepared for this Study by the Geological Survey of Iran (GSI). This geological map basically presents the distribution of the Pliocene and Quaternary alluvial and glacial deposits in the Tehran plain between 51°00'-51°44'E and 35°28'-35°22'N. The classification of alluvial deposits according to Rieben (1996) is used as the basis for mapping different lithologic units of the Study Area. The geological map of the Study Area is shown in Figure 2.2.3 and a general section of alluvial deposits of the Tehran region is shown in Figure 2.2.4.

Based on the explanation of this map by M. Ghasemi (1999) and the result of the geological investigation of this Study, the geological conditions of the Study Area can be summarised as follows:

(1) Bedrock

Rock units older than ***A*** formations in the map area are designated as "bedrock." In northern Tehran, where the Alborz Mountain Range is located (above the North Tehran Fault zone), this unit is basically composed of Eocene pyroclastics (green tuff) and volcanic rocks that form high outcrops north of the Tehran Plain. In the eastern Sepaieh and Bibi-Sharbanu Mountains, bedrock includes limestone and dolomite of the Triassic and Cretaceous ages, some conglomerate of the Paleocene age, volcanic rocks of the Eocene age, and intrusive rocks of the Tertiary (Oligocene) age.

In the south and southwest, bedrock is composed of Eocene volcanic rocks.

(2) *A* formation (Hezardarreh formation)

The name of this formation originates from the geomorphic nature of outcrops of the formation. "Hezar" means "thousand" and "darreh" means "valley." Northern outcrops of ***A*** fm. are limited from the south to the 35°43' latitude, however, some outcrops of this unit are present in southern hills of the Tehran plain (south of the Kahrizak fault).

The ancient alluvial deposits of ***A*** fm. essentially include conglomerates with a few lenses of sandstone, siltstone and mudstone, and are recognizable by regular stratification, relatively thin layers, small clasts, and advanced stages of decomposition of the constituents. Carbonate cementation is well developed in this formation, as compared to other younger units, resulting in higher relative mechanical competency. Based on the geological investigation in this study, most of the N value in this layer exceeds 50.

The clastics are almost totally composed of pyroclastic material and volcanic rocks of the Eocene age, derived from the northern highlands. Average grain size of the clastics is in gravel range (10-25 cm). Color is light gray and has a chalky appearance. Thickness is estimated to be about 1200 m. Relatively extensive cementation, high compaction, and presence of fine grained matrix renders the *A* fm. as an impermeable rock unit, as compared to other alluvial deposits of the Tehran region.

According to stratigraphic correlation with other parts of the Iranian plateau, the ***A*** fm. is considered to be of the Pliocene-Pleistocene age. The ***A*** fm. in the northeast and east of Tehran rests over the Upper Red fm. (Miocene). However, in a few places south of the Tehran plains, it overlies the volcanic rocks of Eocene age. Gradational contacts of the ***A*** fm. over the marl and mudstone of Upper Red fm. is reported in the east of the Tehran region.

The ***A*** fm. was folded and faulted during the earliest tectonic movements of Quaternary time, resulting in unconformable contacts of the ***B*** fm. with younger Quaternary deposits. The resulting high dip (up to 90° in some places) is, therefore, a diagnostic feature for the ***A*** fm.

(3) *B* formation

This formation was first named and described by Rieben (1966) as Kahrizak fm. The formation is divided into a northern facies and a southern facies.

a. B_n formation (North Tehran inhomogenous alluvial fm.)

The B_n fm. unconformably overlies on the eroded surfaces of the ***A*** fm. and forms old alluvial fan topographic units in the north of the city of Tehran.

Thickness of the B_n fm. is estimated at about 60 m. The B_n fm. is a conglomeratic mixture of gravel, pebble, and cobble-size clastics, which include a silt and sand size matrix. Therefore, the B_n fm. is an inhomogeneous unit with poor sorting. The diameter of some boulders in the B_n fm. reach about 4.6 m. In many places, the conglomerate is of matrix supported type, which lacks any stratification. Cementation is poorly developed in the B_n fm., but its N value exceeds 50 in most parts. Color is reddish and yellowish brown, which makes the B_n fm. darker than the underlying ***A*** fm. Several lenses of silt and sand in this formation appear to be of channel origin that are cut and filled by these deposits. In many places, a soft black and yellow cover, which is, respectively, of magnesium and iron oxide composition, is present on pebbles within the formation.. Permeability of the B_n fm. is very good.

Thickness of the B_n fm. decreases towards the south, and its outcrops are limited from the south to the 35°43' latitude. It is suggested that the B_n fm. was deposited within alluvial fans formed by a series of outwash flows of glaciers from the Alborz Range. Presence of large blocks of clastics supports the concept of this formation's a glaciofluvial origin.

The B_n fm. is considered to be of Pleistocene age. The B_n fm. is faulted in many places, however, it is not affected by any major folding event; therefore, bedding is generally horizontal with a maximum dip of 15°.

b. B_s formation (South Tehran clayey silt or Kahrizak fm.)

The B_s fm. is widely distributed under the topographical plain unit. Outcrops of the B_s fm., which are exposed as a result of faulting, form the badland scenery in the southern parts of the Tehran plain. However, the soil condition of this area is not so strongly consolidated, and, from the engineering geotechnical point of view, these outcrops may belong to the ***C*** formation.

The B_s fm. is composed of reddish brown-, cream- and beige-colored silt with some clayey component. Small calcareous nodules are scattered within this formation in many places. Composition of the B_s fm. is much more homogenous, as compared to the B_n fm. in the north, however, no sharp stratification is present within it. The B_s fm. is considered as the southern equivalent of the B_n fm. that was presumably deposited within an old lake basin. The northern and eastern part (i.e., nearer to the mountain area) of this deposit is composed of coarser material (sand rich material) and its N value is relatively high. The south-western part of this layer is composed of homogeneous, fine material (clay rich material) and N value is relatively low. These clay rich deposits are considered as overconsolidated and cemented. The N value for most of the B_n fm. is more than 50. However, soft clay lenses with an N value less than 20 can be found in some parts.

The lower contact of the B_s fm. is not exposed; however, it is postulated that it overlies the ***A*** fm. and the bedrock (Eocene volcanic rocks). Thickness of the B_s fm. is uncertain, but it is

possibly much thinner than its northern equivalent, the B_n fm. In this Study, three boreholes were drilled to depth of 200m in the southern area. However, no lower contact of the B_s fm was found in this investigation.

Faulting has affected the B_s fm. in many places; however, it lays horizontal without any tilting.

(4) *C* formation (Tehran alluvial fm.)

The ***C*** fm. includes conglomeratic young alluvial fan deposits. Lithology of the formation includes homogenous conglomerates, composed of gray to brown coloured gravel and pebble size clastics, which have a silt and sand size matrix. Color of the ***C*** fm. becomes red to reddish brown in the eastern Tehran region because of a difference in rock type of the source area (Sepayeh Mountains). The stratification within the ***C*** fm. is better than within the ***B*** fm., but less developed than within the ***A*** fm. Among the old alluvial fans, where this formation was deposited, the old fan of the Kan River (western Tehran) is still visible in aerial photographs. The Karaj Fan, which is now covered with the D_2 unit, is also composed of the ***C*** fm. The extreme southern outcrops of this formation are limited to the 35°39' latitude. A considerable part of Tehran is constructed over the ***C*** fm.

The maximum thickness of this formation is estimated at be about 60 m. Several (up to 4) major depositional cycles may be defined within the ***C*** fm. These cycles are easily recognised by a change in the colour from gray to white into brownish red (bottom to top). The white and red colourings are attributed to the presence of caliche and iron oxide, respectively. Cross bedding is present in few places within the middle part of the ***C*** fm. Age of the ***C*** fm. is estimated to be between 50,000 and 10,000 years (late Pleistocene).

The ***C*** fm. is more competent as compared to its underlying and overlying stratigraphic units (***B*** and ***C*** formations, respectively). This phenomenon is a result of the relatively higher cementation and compaction of this stratigraphic unit. However, permeability of the ***C*** fm. is high so that it constitutes the major aquifer of the northern Tehran region.

Minor faulting is present within the ***C*** fm.; however, no tilting is visible in this formation.

The N value of the ***C*** fm. is slightly lower than that of the ***A*** and ***B*** fm. but exceeds 50 in most of the C fm.

(5) *D* formation (Recent Alluvium)

The ***D*** fm. is the youngest stratigraphic unit within the Tehran region and is present as alluvial and fluvial deposits. In this study, the ***D*** fm. is subdivided into two different stratigraphic units, named D_1 and D_2 units.

a. D_1 unit (Khoramabad alluvial fm.)

The D_1 unit, as a veneer, covers the ***Bs*** fm. in the south and forms a topographic plain unit. This unit is composed of fine silt with a grayish cream and gray colour, and is sandy and pebbly in places. Basically, sandy material is richer in the northern and eastern parts of the plain. Fine material, such as silt and clay, is predominant in the south-western part of the plain. No sharp stratification is present within the D_1 unit. The D_1 unit is considered to be both the distal facies and slightly older equivalent of the D_2 unit in the northern Tehran region. Age of the D_1 unit is considered to be younger than 4000 years (Holocene).

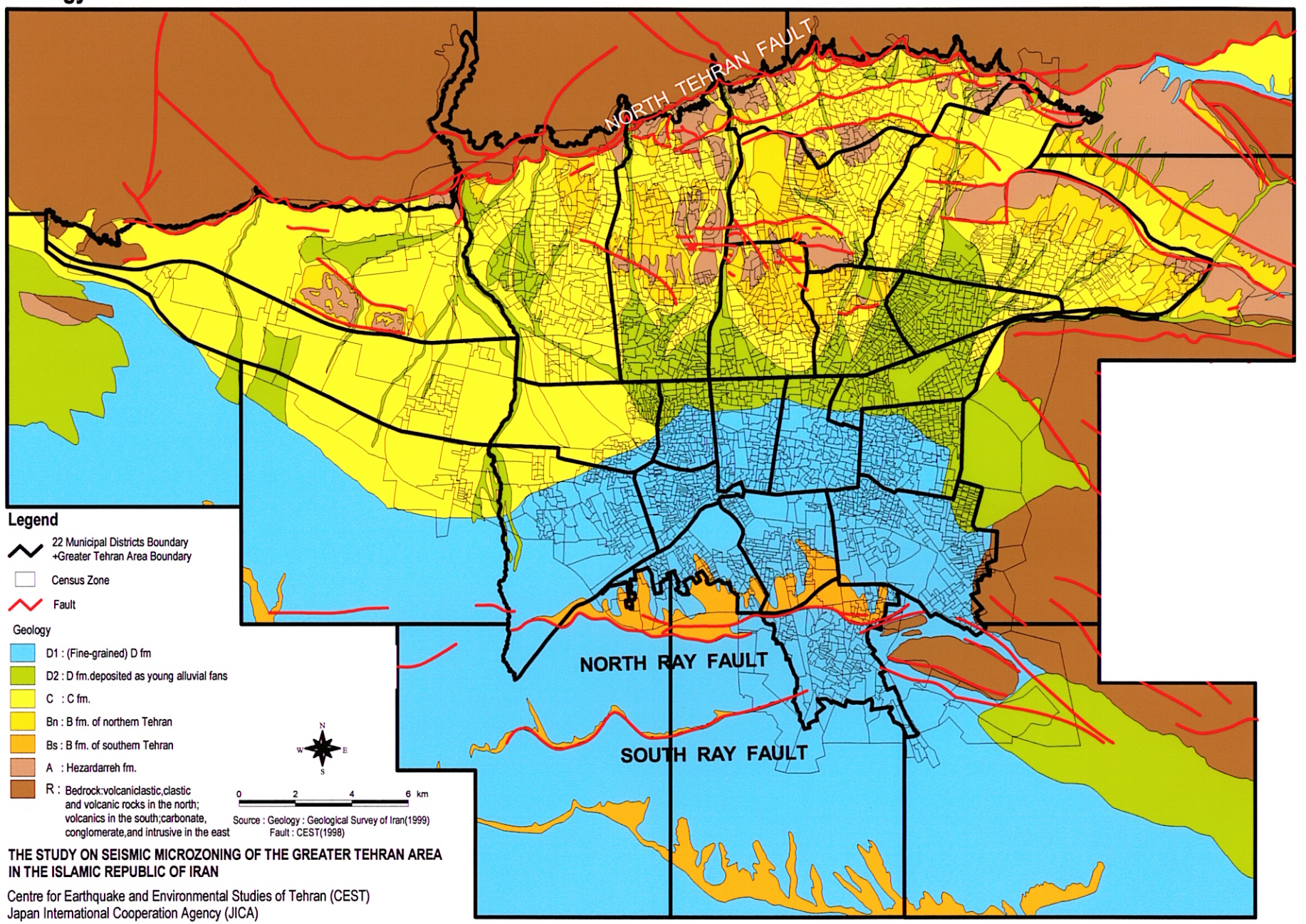
b. D_2 unit

The D_2 unit is composed of poorly consolidated to unconsolidated gravel- and pebble-sized calstics, which have a silt and sand size matrix. The colour is gray to dark gray. This unit

has an alluvial and fluvial origin, similar to the ***C*** fm.; however, the lack of cementation, lesser compaction, and lack of caliche and iron oxide may easily distinguish it from the latter. Competency of this unit is lower than that of the ***C*** fm. The young, active alluvial fans and flood plains in the northern Tehran region are composed of the $\boldsymbol{D_2}$ unit.

Figure 2.2.3

Geology



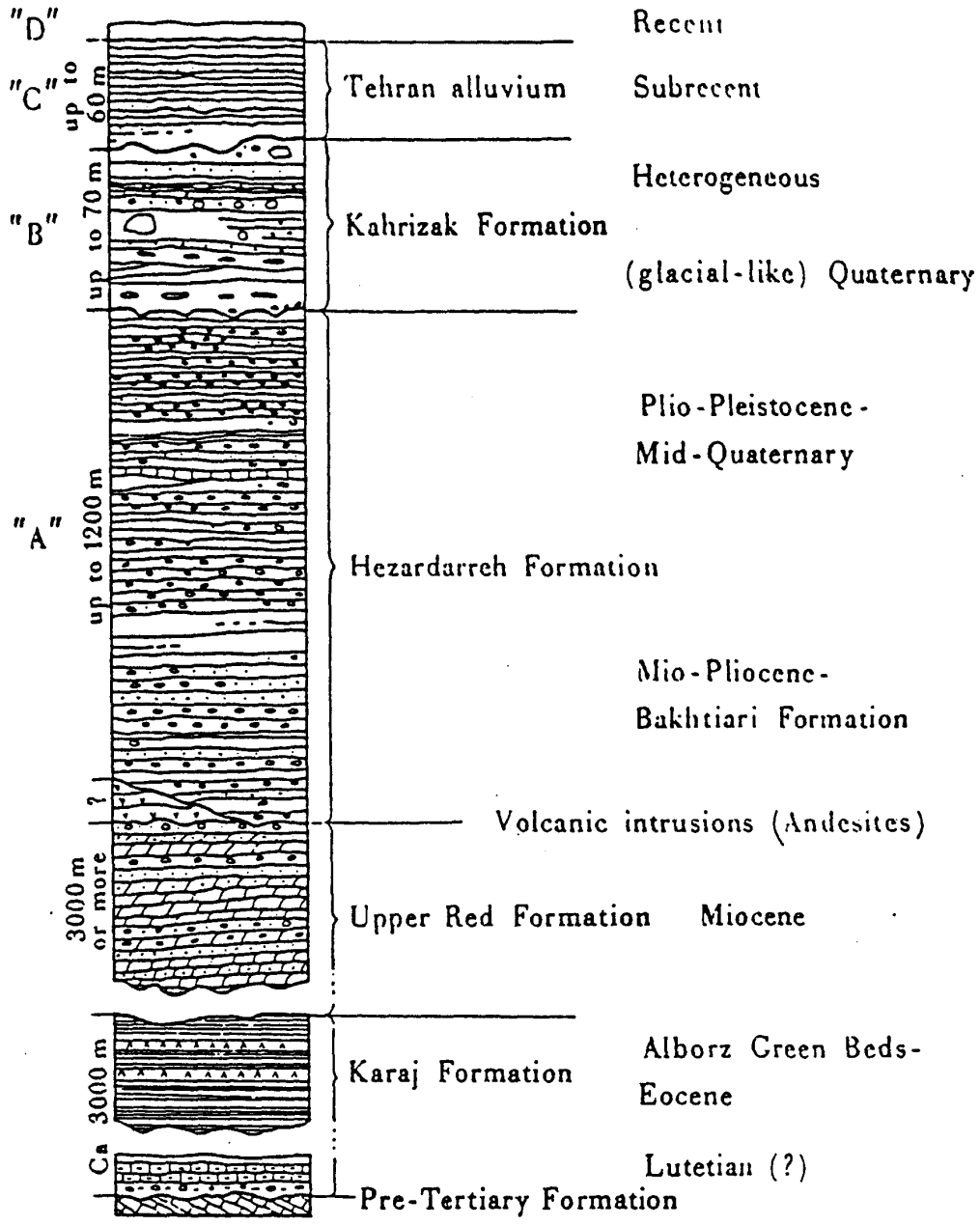


Figure 2.2.4 General section of alluvial deposits in the Tehran region

Source: Geological Observations on Alluvial Deposits in Northern Iran, H. Rieben, Geological Survey of Iran, Report No.9, 1966.