PIPING IN A CAVE-FORMING CLAYSTONE-INJANA FORMATION, KARBALA – NAJAF AREA

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ABSTRACT

A Cave-forming claystone bed, just below Dibdiba Formation has been studied. This bed ranges in thickness from 6 – 10 m or more, and has a considerable extension (about 180 Km) along Tar Al-Najaf and Tar Al-Sayyed.

The study indicates that one of the interesting geological hazard phenomenon (piping) is well developed in that bed. It is clear that the main reason for the caving in the claystone bed is the water erosion, particularly along the remarkable joints (two set of joints), the north-south and east-west direction.

A well defined irregular holes due to piping has been noticed in this bed, they are of different shapes and sizes that reach (11.0 x 1.25 x 8.0 m) dimensions. These holes are scattered on a small exposed plateau of the cave-forming claystone. This bed has been exposed due to backward erosion of the overlying Dibdiba Formation. The study also indicates that piping phenomenon should be taken in consideration for any heavy construction on Karbala – Najaf plateau, and that the cave-forming claystone represents a uniform quite fluvial environment.
INTRODUCTION

The studied area represents the southern and western scarp of Karbala – Najaf plateau. It extends along Tar Al-Najaf and Tar Al-Sayyed. Al-Razzaza lake represents the north-western boundary and Bahr Al-Najaf represents the southeastern boundary of the studied area (Fig.1).

Fig.1: Location map

Piping is effective on materials ranging from clay to gravel size. It is effective on silt, losse, volcanic ash, soil as well as on bed rock of claystone, siltstone, mudstone and tuff; (Fairbridge, 1968 in Al-Khateeb 1996).

Piping phenomenon in claystone bed just below Dibdiba formation has been noticed in some places along Tar Al-Najaf and Tar Al-Sayyed. This phenomenon should be studied and avoided in any heavy construction.
Barwari and Slewa, 1995, mentioned that the exposed formations along the scarp of Tar Al-Najaf and Tar Al-Sayyed are Fatha, Injana and Dibdiba Formation.

In the present work, the authors believed that only Injana and Dibdiba formations are exposed along the scarps of Tar Al-Najaf and Tar Al-Sayyed, while the Nfyail (previously named Fatha) Formation is exposed as isolated hills or plateaus just south and west of the scarp, or near the toes of the scarp, particularly around the junction of Tar Al-Najaf and Tar Al-Sayyed.

It is worth to mention that in the studied area, the so called Fatha formation by Barwari and Slewa, 1995 is formally named Nfyail Formation (Sissakian, 1999).

The exposed formations along the scarp of both cliffs are:

1. **INJANA FORMATION**

   It represents the main bulk of both scarps and it can be divided into two parts; the lower part: consists of alternation of sandstone, siltstone and claystone, the sandstone is grey, cross-bedded, the siltstone and claystone are generally of brown to reddish brown colour. Thin green claystone and marl or marly limestone beds occasionally present through the sequence. The thickness of this part reaches 15 m.

   The upper part: generally consists of claystone to silty claystone, brown to reddish brown, jointed with two sets of joints (E – W and N – S directions). In some places along Tar Al-Najaf, particularly near the junction with and Tar Al-Sayyed where the piping is clear and remarkable, the upper part can be divided into two beds (Plate 1), the lower claystone bed which consists of brown claystone, jointed (two sets of joints E – W and N – S), topped by marl or marly limestone of 0.3 m thick. The upper claystone bed which consists of brown silty claystone, occasionally interbedded with rare thin and small (30 x 60 cm) coarse sandstone lenses, this bed is highly jointed and topped by greenish grey marly limestone bed of about 0.3 m thickness with colour, Fig. (2).

   ![Plate 1: Two claystone beds of Injana Formation](image-url)
2. Dibdiba Formation

It is composed of coarse grained sandstone, pebbly sandstone, generally of brown colour, dominated by quartz with some feldspar and rock fragments it reaches up to 12 m in thickness, and represents the exposed surface of the plateau.

The contact between Injana and Dibdiba formations is clear and remarkable, taken at the top of green marl or marly limestone which belong to Injana formation and the base of the brown sandstone or pebbly sandstone which belongs to Dibdiba Formation.

THE CAVE-FORMING CLAYSTONE

It represents the upper part of Injana Formation. Along the western part of Tar Al-Najaf near the junction with Tar Al-Sayyed, this part is well developed. It consists of brown claystone, silty with rare small (30 x 60 cm) coarse grained sandstone lenses, topped by 0.3 m greenish grey marly limestone. This bed is highly jointed with two sets of joints (E – W and N – S).

These joints, particularly those which are perpendicular to the bedding were enlarged gradually due to piping phenomenon (subsurface erosion), forming well developed caves in some places (Plate 2). These caves are scattered along the claystone bed, but they are concentrated in some places where the piping is active.
Plate 2: well-developed caves in the clayston bed

This bed has a remarkable extension along the whole Tar Al-Najaf and Tar Al-Sayyed for about 180 Km. with the same characters, it is considered to be a marker bed for mapping in the studied area. Generally cliff-forming, tough and brown to reddish brown in colour, contains some black organic material. This bed is overlain by Dibdiba Formation. The contact with Dibdiba Formation is clear, marked by the presence of a pale green marly limestone of Injana Formation, overlain by brown coarse grained sandstone or pebbly sandstone which belongs to Dibdiba Formation.

- Chemical analysis indicate that the dominated clay mineral is palygo-rskite with some montmorillonite. The claystone is almost silty and calcareous. The wide geographic extension of the cave forming claystone along both cliffs without remarkable lateral change may indicate a quite fluvial environe-ment. This bed is underlain by fine to medium grain sandstone which refer to more active fluvial environment and overlain by coarse grained pebbly sandstone of Dibdiba Formation which indicate high energy fluvial environment.
- It is worth to mention that some people believe that these caves are formed due to anthropologicen activities but this is not true. The caves developed due to water erosion particularly along joints.

**PIPING IN THE CAVE-FORMING CLAYSTONE**

Piping is a type of water erosion of subsurface features initiated due to many different mechanical methods, which result from selective removal of particles from macropores by moving water due to subsurface soil erosion (Fairbridge, 1968).

- piping starts when erosion eliminate in the end of stratified layer and continue upward along fissure (Dregne, 1976), then whole profile collapse into the tunnels.
- The cave forming claystone is overlain by coarse-grained pebbly sandstone with some fine and medium grained sandstone, of brown colour, friable to medium tough, gypseous in places.

The sandstone is sometimes cross-beded, composed of quartz with some feldspar and rock fragments.
This sandstone belongs to Dibdiba Formation and represents the exposed surface of the plateau. It reaches up to 12 m. or more, it is clear that this sandstone is highly permeable, and during rainy seasons the water pass easily through this permeable sandstone bed to the underlying cave-forming claystone, causing selective erosion of the clastic particles (sand and silt particles), making pipes in the claystone bed (Kehew, 1995). Some times the water moves through the joints causing continuous erosion, resulting in enlargement of the joints forming a well developed caves up to 2.5 x 1.5 m or more, particularly in the upper part of the claystone bed (Pl.2). This phenomenon is well developed in many places along both cliffs well developed caves along Tar Al-Sayyed where Karbala – Shithatha road crosses the cliff just north of the road has been noticed.

The piping is well developed also along the western part of Tar Al-Najaf, near the junction with Tar Al-Sayyed (Fig.1), in that place the backward erosion of sandstone of Dibdiba Formation causing an exposure of the cave-forming claystone as a small plateau (Fig.2) along the cliff. A well developed piping is also calear and remarkable on the surface of this bed where many pipes are formed and enlarged gradually along joints similar to sinkholes but of different shapes and sizes (plate 3). Sometimes the pipes are connected with each other and can be easily recognized in the field since they are relatively large in size (Table 1). Even along the scarp of the cliff, piping is clear resulting in many windows along the scarp (Plate 4). It is worth to mention that the development of these pipes gradually started along the joints as a fragmented claystone occasionally very slightly elevated, then the gradual erosion form a small pipe mostly along the joints & generally of irregular shape then this one is enlarged gradually forming a wide irregular holes which reach to 11.0 x 1.25 x 8.0 m, (Plate 5) and Table 1.

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**Fig.3: Backward erosion of Dibdiba Fn. And the exposure of cave-forming claystone**
Plate 3: Different shape and sizes of holes in claystone bad

Table 1: Dimensions of holes (pipes) in the studied area

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Depth (m)</th>
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<tr>
<td></td>
<td>1.60</td>
<td>0.40</td>
<td>1.90</td>
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<td>2</td>
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<td>8.00</td>
</tr>
<tr>
<td>5</td>
<td>5.00</td>
<td>0.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>
CONCLUSION AND RECOMMENDATION

Piping is one of the geological hazards phenomenon that should be taken in consideration and should be avoided in heavy constructions.

This phenomenon is well developed in a cave-forming claystone bed just below Dibdiba formation.

Dibdiba Formation forms the flat surface of Karbala – Najaf plateau; so a geological and engineering geological study for this phenomenon should be achieved before any construction on this plateau, either to avoid the construction on the place where piping was developed or to make artificial treatment by preventing the activity of the flowing water on that place.

REFERENCES