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The investigation of rocks present under and above the Hatshepsut Temple - Deir El Bahari - Upper Egypt.

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Abstract

A geological field investigation of rocks present under and above the temple of Queen Hatshepsut in Upper Egypt was performed. Investigation showed the place prepared for construction of temple was specially prepared. The part of the rocky cliff present at the end of Deir el-Bahari valley was cut by miners (Photo 1a, Fig 1). Observation of temple foundations showed the presence of a thin layer containing remains of human activity represented by fragments of pottery, charcoal, dactyl stones etc. Documenting the area under consideration was the building lot. The construction of architectonic elements of the temple was constructed step by step. Moreover observation of the bases of foundations showed that they are situated on the top surface of limestone layers constituting intercalations in Esna shale or are located on Esna shale cut in the form of steps (Photo 1b, 2a, b). At the same places layers of limestones were used as the roof of underground tombs and chapels. They were perforated from the top down. The chambers and corridors of tombs were shafted in soft Esna shale. Rocky material removed from the cut cliff (Photo 3) was deposited as the base for construction of the middle terrace of the temple (Photo 4a, b)

In conclusion, one can say that the investigation and reconstruction of geology conditions as well as the engineering work helped to understand the general scheme of the phases of the Hatshepsut Temple construction.

Key words: geology, engineering, Hatshepsut temple

Abstrakt

Wykonano geologiczne badania terenowe skał występujących w otoczeniu świątyni królowej Hatshepsut w Górnym Egipcie. Badania wskazują, że miejsce pod budowę świątyni było przygotowywane w ten sposób, że pracami górniczymi obcięto fragment skalnego klifu znajdującego się na

końcu doliny Deir el-Bahari. (Fot. 1a, Fig. 1).). Obserwacje fundamentów świątyni wskazują, że część jej obiektów stawiano na płytach wapiennych występujących w obrębie łupków Esna (Fot. 1b, 2a). W cienkiej warstewce występującej między fundamentem kaplicy Hatshepsut a stropem ławicy wapiennej natrafiono na ślady aktywności budowniczych (fragmenty ceramiki, pestki daktyli, węgielki i in.). co dowodzi, że przed budową tej kaplicy teren był wykorzystywany jako plac budowy. Płyty wapieni występujące w obrębie łupków Esna były wykorzystywane zarówno jako podstawa pod fundamenty jak też jako płyty stropowe dla grobów i kaplic drążonych pod nimi w miękkich łupkach Esna. Same łupki przycinano pod fundamenty w formie stopni (Fot. 2b). Usunięty w wyniku tych prac materiał skalny (Fot. 3) wykorzystano jako „podsypkę" pod środkowy taras świątyni Fot. 4 a, b).

Wykonane badania geologiczne i rekonstrukcja prowadzonych w tym rejonie prac inżynierskich pozwoliły na odtworzenie ogólnego schematu i fazy budowy świątyni królowej Hatshepsut.

Słowa kluczowe: geologia, inżynieria, świątynia Hasthepsut

Introduction

The investigation of the Temple (Barwik 1998, 2000, 2001, Szafrański 2000, 2001) and rocks present under various parts of the Temple gives information concerning the means of preparation of the area for the Temple construction. But for a better understanding it is first necessary to imagine the morphological situation of this place before the Temple construction.

Geologically and stratigraphically a great part of the sediments considered represent Eocene (R. Said 1966, 1990, Pawlikowski 1994). They are represented by clayey, kaolinitic Esna shales present at the lower part of the profile while the upper part is represented by Theban limestones (fig.1.A – T.L.). Esna shales (Fig. 1, A- b, d) are gradually passing into overlaying limestone. This phenomenon is seen as a series of limestone layers in shists intercalating deposits of Esna shists.

The Eocene sediments mentioned above are covered in some places by Pliocene conglomerates (fig. 1 A - f) and younger slope cones composed of Theban limestone fragments which fall down from cliffs (fig. 1, A g- photo. 1a). Therefore, the primary morphology of the area before the Temple construction began may be reconstructed as shown at fig. 1, A, and cross section fig 1, D-A).

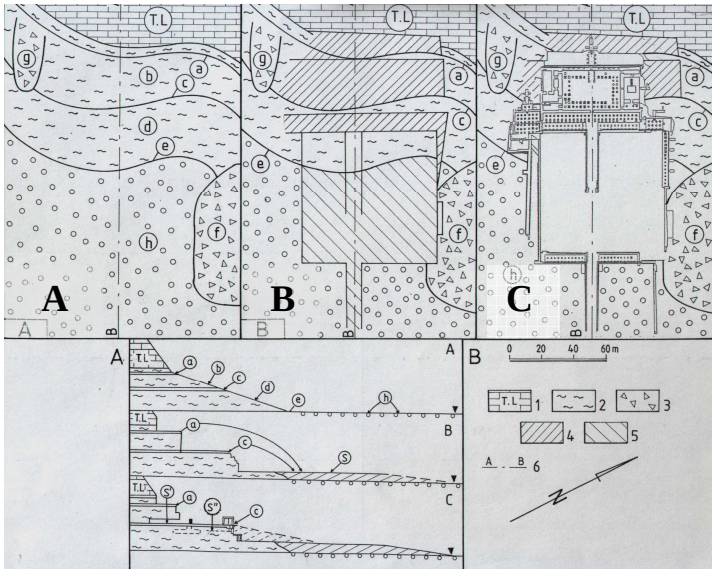

Fig 1 Reconstruction of the sequence of work done during the construction of the Hatshepsut Temple.

Fig. 1 A The map of the geological and morphological situation before the preparation of the area for construction of the Temple. T.L. Theban limestones, a - upper limestone used later as a base for the construction of the upper shelf of the Temple, b, d - Esna shists, c – lower limestone used later as a base for construction of the upper terrace, e - the line of contact of Esna shists with young sediments filling up Deir el Bahari, f - Pliocene conglomerates, g- young slope cone present on the morphological surface of Esna shists, h- young sediments filling up the valley of Deir el Bahari. 1- Theban limestones, 2 – Esna shists, Pliocene conglomerates (f) and slope cone (f), 4- areas of transfer of stone material from gebel, 5 – area of deposition of material removed from gebel, 6 - A - B - line of cross section shown at fig 1.D, A –C.
Fig 1B The map showing the localization of the engineering work preparing for the construction of the Hatshepsut Temple.
T.L. Thaban limestones, a - h - explanation as for fig. 1A, 5- area of the exploration of rocks and their removal, 6 - area of accumulation of the material removed during the exploration of gebel.
A - B - line of cross section shown at fig 1. D-B.
Fig. 1C The scheme showing a present picture of the location of the Temple Hatshapsut.
a - h explanation as for fig. 1A,
A - B - line of cross section shown at fig 1. D-C.
Evolution of the area of the Hatshepsut Temple. Lines of cross sections marked on fig 1A, B, C. S’ – sanctuary of Hatshepsut, S’’ – sanctuary of Hathor.

This means that the Temple of Hatshepsut was built at the contact of two mechanically different types of rocks i.e. lower – soft Esna shist and upper – mixed Esna shist and hard layers of limestone present above the top part of Esna shist. This means that the geotechnical conditions of the lower part of the Temple construction (on Esna shists) and the upper part of the Temple (on shists and limestone) were technically different.

Field examination of profiles and determination of rock present under various parts of the Temple showed that work preparing the area for object construction was focused on removing rock material from the gebel and the deposition of this material mostly under the medium terrace. The places and scale of the engineering works are shown at fig. 1 B, as well as at fig 1D, B.

The observations and investigations document that are most important for the construction of the Hatshepsut Temple two layers of limestone i.e. marked as a and d (fig. 1A –a, d).

Upper shelf

The Upper primary shelf, made by the construction of objects above the Temple is represented by a natural limestone layer (limestone a)

present just at highest part of the profile of Estan shale just under the bottom of Theban limestones (fig. 1A, B – layer a). Esna shales present between this layer and the bottom of Theban limestones were originaly removed during the preparation of the area for temple construction. The layer of limestone (layer a) was left tendetionally for the preservation of the Temple against stone blocks falling down from the highest part of hills built of Theban limestones.

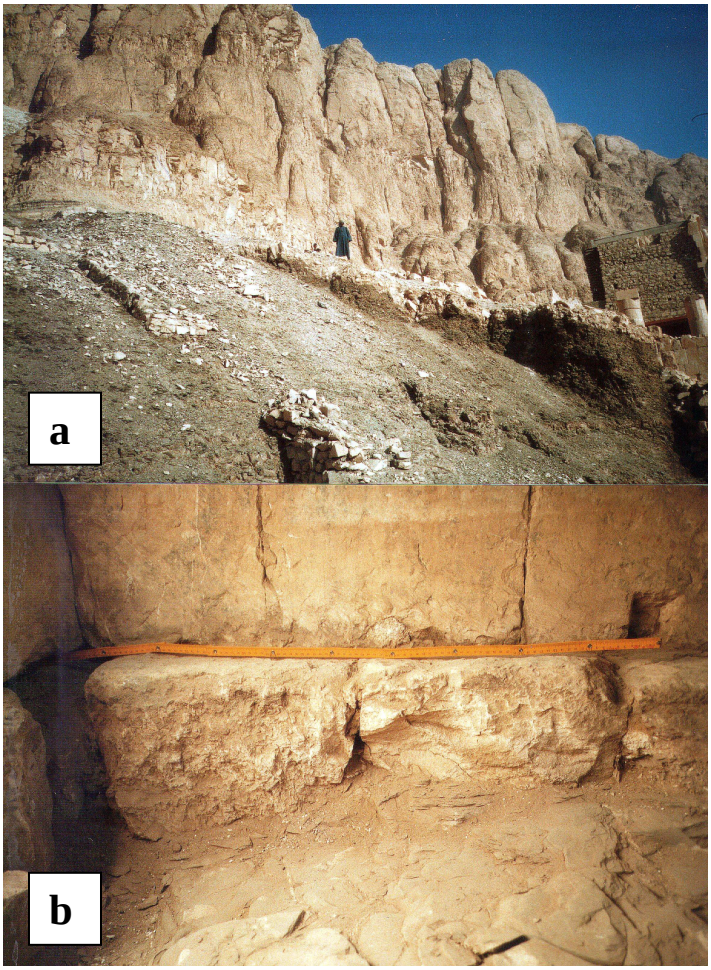

Photo. 1a Rest of slope cone deposited on eroded surface of Esna shales present 30 m to SW from the sanctuary of Hathor.
Photo. 1b Undulated natural surface of limestone constituting the base for the foundation of the Hatshepsut Chapel. Blocks of founding are seen with a specially prepared bottom surface (arrows). West corner of the chapel.

This natural limestone layer (a) was used for better stabilization of the cliff during the restoration works of the Temple. The stabilization was done by the binding of the mentioned limestone layer (a) with a specially constructed stone wall above the upper terrace of the Temple. Because of this work newly constructed artificial shelf composed of a natural limestone layer and a cement-stone shelf made the architectural construction above the upper terrace stable and well preserved against destruction.

Upper Terrace

The work concerning the preparation of the surface for the construction of the upper terrace are easily seen the in chapels located there.

For example, the sequence of layers present under the Chapel of Hatshepsut confirms that this part of the Temple was constructed on relatively thick and strong layer of limestone present at the upper part of the Esna shists (Fig. 1B, layer c). The primary morphology of this limestone is slightly undulated and partially destroyed by human activity (photo. 1b). Observations confirmed the presence of a thin, 2-4 cm thick, layer of powder-like sediment just between the foundation and the natural surface of the limestone. This sediment contains small fragments of dynastic pottery, grains of charcoal, small fragments of wood and small fragments of blue faience (photo. 2A). The presence of these artifacts in the layer between funding and limestone confirms that before the construction of architectonic objects on the Upper Terrace, Esna shists overlaying the layer of limestone (layer c – fig. 1B, C, D) were occupied, quarried. Later, part of this limestone was removed. After this work the top surface of the limestone layer was prepared for the construction of this part of the Temple.

These observations document that not all architectonic objects of the upper part were constructed at the same time. This supposition is confirmed by the thin anthropogenic layer present just under the foundation of the Chapel of Hatshepsut. The presence of this layer confirms that, during the construction of architectonic elements in other parts of the Upper Terrace, the area of the Hatshepsut Chapel was used as the area for preliminary and preparatory work.

The method of construction of the Chapel of Hatshepsut wall foundations is exciting. The first, lowest layer of the foundation blocks shows a very special shape. The upper surface of the blocks is flat while their bottom face repeats the morphology of the natural top surface of limestone layer. This means that the top surface of the limestone layer was not specially prepared for the construction of the foundation while the bottom of the first blocks of walls was specially adapted. This way of work led to a very good fixing of the stone walls of the temple to the natural limestone base.

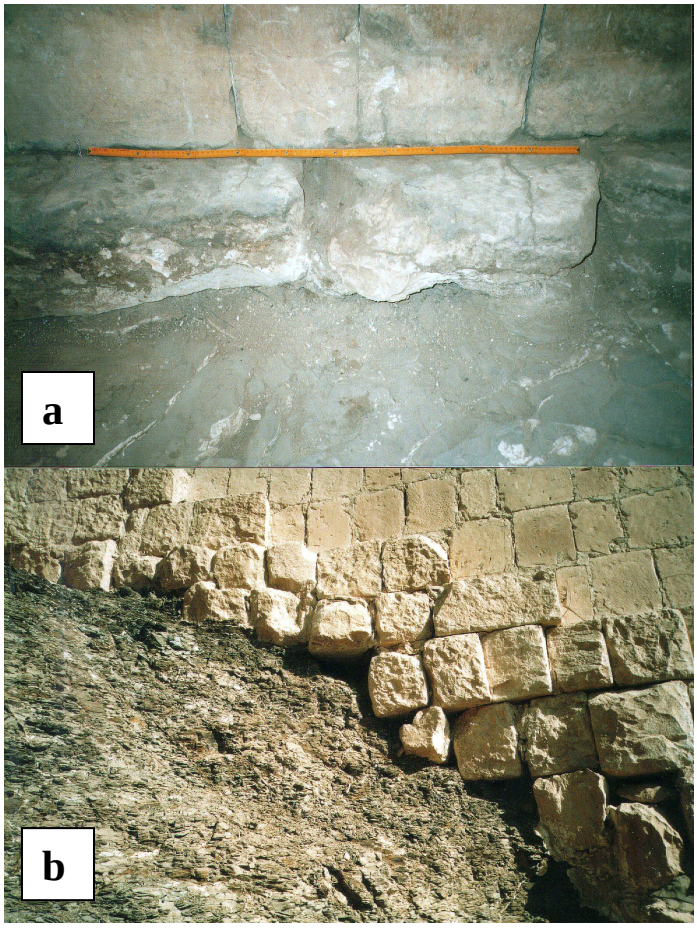

Photo. 2a Thin anthropogenic layer containing small fragments of pottery, grains of dactyl etc. present between the top of limestone c and the base of the fundation of Chapel of Hatshepsut.
Photo. 2b The locations of limestone blocks present under columns of the upper terrace on the specially prepared steps cut into the Esna shists.

The location of the Upper Terrace of the Temple between limestone a and c (fig 1b, fig, 1 C, fig. 1 D) gives additionally a perfect opportunity for the construction of the Sanctuary of Hatshepsut and the chapel of Amun (etc.) at the soft Esna shale present between the limestone layers. Moreover the overlaying layer of limestone a makes a roof above the Sanctuaries.

Moreover the lower limestone layer – layer c (fig. A, B, C, D) constitutes a stable foundation for the construction of the upper terrace as well as for other objects located there. On the other hand, this layer c constitutes a solid roof of tombs present under this part of the Temple as as well as a roof above part of the Sancturay of Hathor and other objects located on the level of themedium terrace.

One can add that during the preparation of the tombs (under the upper terrace) the first work was focused on perforation of limestone layer c. Next, traditional chambers and corridors of the prepared tombs were dug under this limestone in soft Esna shale.

One can say that the Sanctuary of Hathor was prepared using the same type of construction i.e. the chambers of the sanctuary were dug in soft shale just under limestone c while the overlaying limestone was treated as a very solid roof for the greater part of this Sanctuary (fig. 1 B, C).

Moreover, one can say that there was the way for the location of the foundations of columns.

Photo. 3 Medium terrace of the temple. One can see gray area of Esna shale that were removed during preparation for theconstruction of the temple. Artificially constructed part of the terrace was composed of block removed from the upper terrace and covered with limestone plates as shown lower.

In conclusion, one can mention that it is possible to discover other objects (not discovered up to now) which are located behind the stone walls covering natural exposures of Esna shale at the upper terrace (shale between limestones a and c) as well us under limestone c.

Medium Terrace

The medium terrace was only partially located on Esna shale. The chapels and columns of this terrace were located on a specially prepared surface. Moreover, observations confirm that the greatest part of the medium terrace was built on stone material removed from the area prepared for the construction of the upper as well as the medium terrace (fig. 1D – B, photo 3, 4a, b).

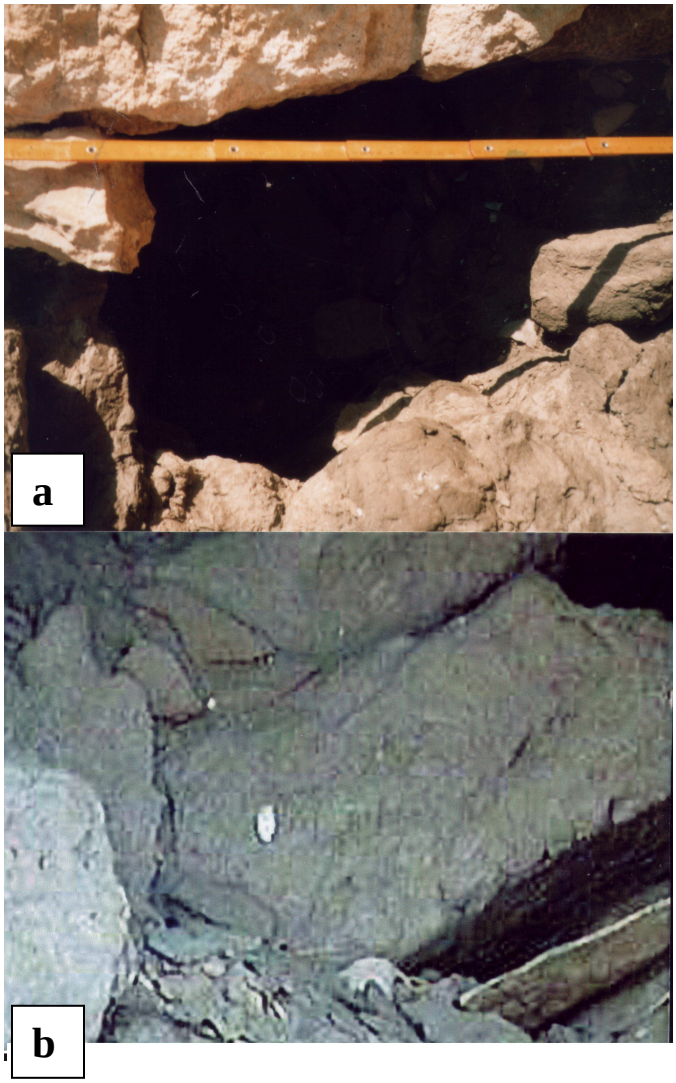

Photo 4a The hole at the base of the wall of the medium terrace.
Photo 4b Blocks of limestones seen in the hole shown above. Blocks constitute fragments of the cliff removed from in situ during preparation of the place for the construction of the upper terrace sculptures of Pharaoh at the upper terrace which is very special. The top part of Esna shale present stratigraphically under limestone c is well prepared for those constructions. One can see the preparatory work as steps cut in shale. Blocks of the foundation are precisely located at fixed places on these steps (Fig. B, Site 1, photo. 2b).

Lower Terrace

The lower terrace is constructed mostly on natural young sediments filling up Deir el-Bahari. They are represented by stream deposits composed mainly of fragments of limestone and sands (fig. 1C, fig. 1D-C). All sediments overlay thick layer of limestone present under Esna shole. This lowest limestone is the place for the location of the next generation of tombs present for example near the Metropolitan House.

But it is possible that under lower terrace of the Temple of Hatshepsut large tombs are present that have not been discovered up to now tombs.

Summary

The morphological, geological and architectonic details already mentioned lead us into the consideration that most probably the upper part of the Temple (the upper terrace) was constructed as the first object. Sediments removed during preparation of the area were transported down where they were used in the construction of the medium and lower terrace of the Temple. The understanding of this work helps us reconstruct phases of construction of the object. Additionally, the described phenomena gives imagination concerning the geological knowledge of the constructors as well as confirming the great scale of preparing engineering work done before building of the Temple.

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