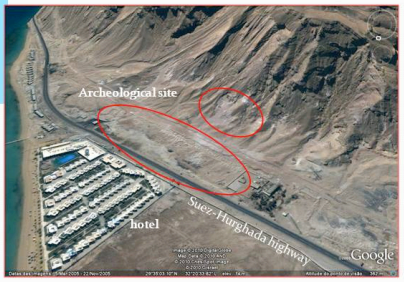
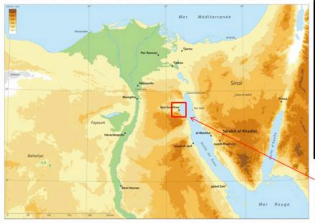
Time scales and geoarcheology: stability *vs* instability of the ancient maritime site of Ayn Sukhna, Gulf of Suez, Egypt

Jean-Pierre Peulvast, UFR de Géographie, Université Paris-Sorbonne, 191 rue Saint-Jacques, 75005 Paris, France.
E-mail: jean-pierre.peulvast@wanadoo.fr
Pierre Tallet, UFR d'histoire de l'art et archéologie, Université Paris-Sorbonne, 6 rue Michelet, 75006, Paris, France.
E mail : pierre.tallet@wanadoo.fr

Introduction

Studied for the years 2000, the archeological site of Ayn Sukhna is located on the western coast of the Gulf of Suez, on the narrow piedmont of arid sedimentary plateaus, close to a thermal spring and at the outlet of the shortest way linking the gulf to Memphis, 60 km S from Suez.
Built and occupied at the times of the Old Kingdom and then of the Middle and New Kingdom, and until the Ptolemaic period (between 2600 and 300 y BC). Partly obliterated and separated from the sea by modern constructions, but two parts remain accessible: remains of dwellings on colluvial fans and shore platforms of the piedmont, and a set of 10 galleries (stores) excavated in the base of the Gebel Galâla el-Baharyya.





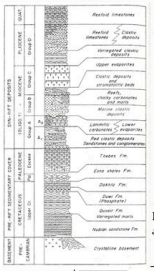
The study area: rift shoulder, arid coast

Objectives and methods

Geomorphological study of the site and its surroundings, by the means of field work, precise topography, image interpretation (air photos, Google Earth), drawing of block-diagrams and maps, integration of archeological data, in order:
- to understand the potential and constraints that lead the Ancient Egyptians to use this site as a maritime base for expeditions towards the Sinai, storage of boat pieces, and production of copper.
- to define the conditions of natural stability or instability that allowed its preservation until the recent period (shore line, hill slope and piedmont).

Physiographic features

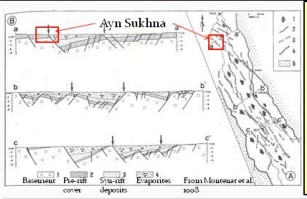
Gebel Galâla el-Baharyya: northern part of a high plateau gently sloping westward (1180-500 m) from the Gulf of Suez to the Nile valley.
Promontory at the intersection of a wide EW corridor and the abrupt coast of the gulf.
Archeological site: at the foot of a small and lower compartment : Khasm el Galâla (580 m), on a narrow strip of dissected pediments and shore platform.
Hyperarid conditions (2.4 mm/y at Suez)



Geological context

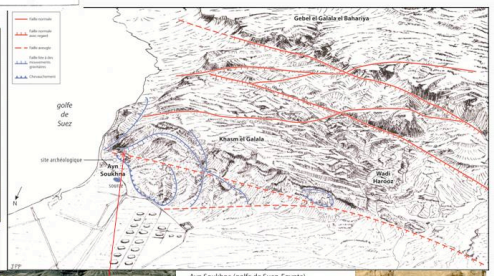
West shoulder of the Suez rift, initiated in the Oligocene (34 My)
Paleocene-Eocene: carbonates, pelites; Mokkatam Group, Thebes Fm: chalky limestones
Late Cretaceous: marls, dolomitic limestones, chalk
Cretaceous: Nubian sandstone (60-200 m)
Early and mid- Jurassic: argillaceous sandstones, mudstones, clay
Pre-rift sedimentary series: Jurassic to Eocene, transgression from the south on the African-Arabic platform (Tethys)

From Montenat et al., 1998



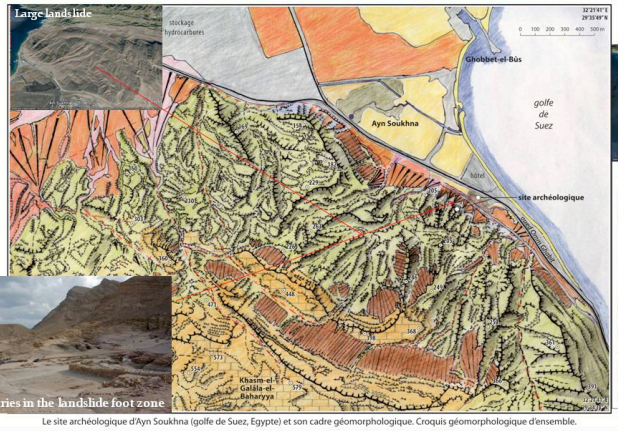
Tectonics and morphostructural features

Uplift related to rift formation and syn-rift sedimentation (Late Oligocene to Langhian clastic series , 2000 m of Serravallian to Late-Miocene evaporites (gypsum), Plio-Quaternary carbonates and clastic sediments
Gebel Galâla el-Baharyya , Khasm el Galâla: tilted blocks, faulted along NW-SE and EW faults (total throw: up to 5000 m along the gulf); Activity until the Late-Miocene, present stability.
Fault scarps, along conjugated to the rift master faults , dissected and karstified structural surfaces (chalky limestone) at the top
A few tilted blocks and gravitational structures over the rift (mechanical weakness of some beds in in the pre-rift series, and of the rift sediments: evaporites)



An antique site built below a major gravitational structure

A huge landslide in the north face of Khasm el Galâla, over the archeological site
Concave scar at the top, 1.7 km long
Below: large bulge, 380 m high, capped by a piece of the top surface (150 m wide), protruding over 200-600 m onto the piedmont plain
Deep gullies on both sides, along listric fault of the rotational slide
Huge slump, 200 m wide, 500 m thick, tilted southward (inward), with short horizontal or upward translation along Jurassic pelites
10 galleries dug in clays and thin sandstone beds in the thrust zone: mechanical weakness



Le site archéologique d'Ayn Soukhna (golfe de Suez, Egypte) et son cadre géomorphologique. Croquis géomorphologique d'ensemble.

Spectacular but weakly active continental dynamics

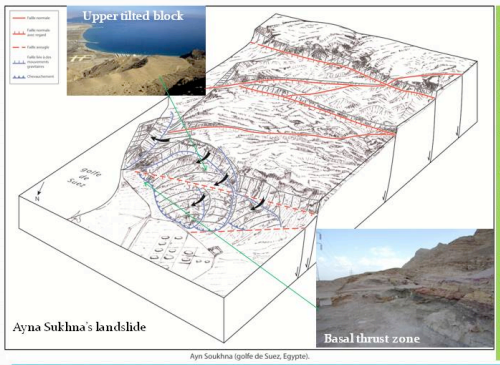
Old age and probable stability

Older than the archeological site
Deep gullying, but no deformation, neither in the colluvial deposits nor in the shore platforms, including the oldest (eutyrrhenian)

Probable role of the mass movement in the location of the thermal spring at the foot of the slump (obliteration of the master fault and of the water circulation)

Hyperarid conditions

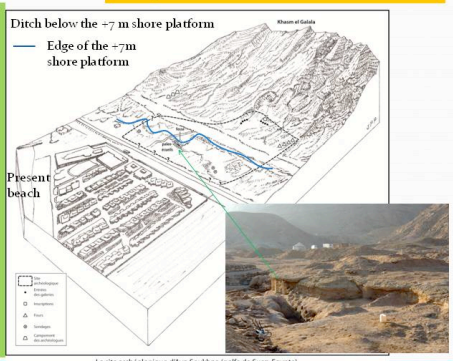
Strong rock disintegration: widespread regolith, talus (thermoclasty, ?)
Granular disintegration (taffoni:haloclasty), but relatively good preservation of antique inscriptions (~4600 years) on Nubian sandstone
Colluvium, alluvial fans, short debris flow: weak activity



Ayn Soukhna (golfe de Suez, Egypte).

Shore zone stability

Lower part of the site: partly obliterated or destroyed (big hotel between the beach and the Suez-Hurghada road, waste disposal, pipe-line, power line, parallel dirt-road).
However; well preserved remains of a shore platform (cemented shingle of local origin) between +6 and +7 m:
-locally in the form of sinuous promontories with remains of dwellings and a 15 m long ditch interpreted as a former facility used for building or dismantling the ships stored in the galleries between two expeditions.
in fact a fracture zone of the former +6 m wave-cut platform
This shore line, and a slightly lower one (+5.5 m): in topographic continuity with the regionally recognized Eutyrrhenian (isotopic stage 5e) shore line and a retreat stage. No local tectonic deformation.
No local or regional indication of higher sea level in the Antiquity



Le site archéologique d'Ayn Soukhna (golfe de Suez, Egypte).

Conclusion

At large- and mid-scale: gravitational instability responding to faulting and uplift which probably ceased in the Late Miocene, producing a huge landslide in which part of the site is inset. Obliterating the Gulf of Suez rift faults, this landslide may have modified the underground water flow and determined the presence of a thermal spring at its foot.
No sign of recent activity at the base of the mountain, else than effects of slow rock-disintegration and of episodic rock falls, gullying and sudden wadi flows.
With its altitudes of 6-7 m, in the continuity of the regional Tyrrhenian shore-line, and its lack of deformation, the ancient shore platform on which part of the site is built confirms a Pleistocene and Holocene tectonic stability. Its study and that of younger shore deposits contradicts older speculations on significant variations of the shore-line since the Antiquity.

References

Abd el-Raziq, M., Castel, G., Tallet, P., Ghica, V., 2002. Les inscriptions d'Ayn Soukhna. MIFAO-122. Institut Français d'Afrique orientale, Le Caire, 135 p.
Montenat, C., Ott d'Estevou P., Jarrige, J.J. Richert, J.P., 1998 b. Rift development in the Gulf of Suez and the north-western Red Sea : structural aspects and related sedimentary processes. In: Purser, B.H. and Bosence, D.W.J., *Sedimentation and tectonics of rift basins: Red Sea-Gulf of Aden*. Chapman & Hall, London, 97-116.
Plaziat, J.C., Baltzer, F., Choukri, A., Conchon, O., Freytet, P., Orszag-Sperber, F., Raguideau, A., Reyss, J.L., 1998. Quaternary marine and continental sedimentation in the northern Red Sea and Gulf of Suez (Egyptian coast) : influences of rift tectonics, climatic changes and sea-level fluctuations. In: Purser, B.H. and Bosence, D.W.J., *Sedimentation and tectonics of rift basins: Red Sea-Gulf of Aden*. Chapman & Hall, London, 537-573.