

ADULIS IN ITS REGIONAL MARITIME CONTEXT. A PRELIMINARY REPORT OF THE 2015 FIELD SEASON

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Introduction

The site of Adulis, hub of the Mediterranean-Indian Ocean trade, is located on the western shore of the gulf of Zula, circa 5km from the coast. According to literary sources the town was served by landing places and harbours dislocated on the western coast of the gulf of Zula and on the islands.

Earliest investigations in the Adulis region were started in 2004-5 by an Eritro-British team of the Asmara and Massawa museums and of the Southampton University. They had the merit to have provided a preliminary archaeological and geo-archaeological assessment of the area, identifying the Galala hills, 5km to the south of the site, and the island of Dissei, outside the gulf of Zula, as the two main landing places serving Adulis in antiquity (Peacock and Blue 2008). They also identified two sites 5-6 km to the north of Adulis as the ancient Samidi depicted in the 6th century Christian Topography of Cosmas Indicopleustes.

In February 2015 a joint team of archaeologist, geo-archaeologists and geomorphologist from Massawa and Asmara museums and the "L'Orientale" and Aix-Marseille universities, resumed these investigations in the Adulis region¹.

The survey focused on the hills/paleo-islands of Galala and in the Irafalo bay with the aim to identify archaeological evidence and to reconstruct the history of the vegetation and coastal paleo-geography since 6000 years. Other investigations focused to the north of Adulis and along the Haddas river bed, from Adulis to the coast, with the aim to assess archeological

evidence, to reconstruct the history of the fluvial activity and to assess flood risk for the site.

Coastal geomorphology fieldwork at the western gulf of Zula: stratigraphy and geo-archaeological issues

(C. Flaux and Ch. Morhange)

The site of Adulis lies within a delta fan, drained and deposited by the Alighede and Haddas rivers and numerous tributaries (Fig. 1). As noted by previous research, while historical accounts from Antiquity testified that the city was at this time ca. 3,3km distant from the shore, Adulis lies today some 5km from the coastline, indicating a great alluvial activity since the last 2000 years (Peacock and Blue, 2007; Alemseged, 2011). This horizontal progradation is expressed vertically in Adulis, where excavated archaeological remains, mostly dated from the 5th-7th century AD (Zazzaro *et alii*, 2014), have been buried below ca. 2 m of fluvial silts and sands. By contrast, the modern configuration of the site and of the delta shows that important fluvial incision has taken place in recent times, up to 4 m depth, which in part threatens the ancient remains of Adulis. In addition, given the tectonic context of the region, lying north of the Afar-Danakil depression, the triple junction zone where the Red Sea, Gulf of Aden and the East African rifts meet (Ghebreab *et alii*, 2000), crustal mobility may be another factor of geomorphological changes in the area and could have impacted occupation history of ancient Adulis. Seismicity has been recorded in the port city of Massawa, ca. 40 km north of Adulis, both in modern (Ogubazghi *et alii*, 2004) and ancient times (Ambraseys *et alii*, 2008).

These observations show that the sector of Adulis has been prone to important geomorphological changes, both in ancient and modern times. The environmental history of the area thus may have greatly interacted with the occupation's geography and trajectory of ancient Adulis.

¹ The fieldwork took place with the financial support of UNO (departmental research grant 2014, grant for the research activities in Asia and Africa, and grant of CISA), of the MIUR Giovani Ricercatori Rita Levi Montalcini program, of the Aix-Marseille University, of the Institut Universitaire de France (IUF) the Eritrean Government and Gruppo Piccini. The research activities of the expedition are also contributing to the Futuro in Ricerca 2012 project code RBFR12N6WD and GEOMED project granted by A*MIDEX.

The authors have conducted a survey and coring investigations of the coastal stratigraphy and geomorphology, at some sites along the western and southern bay of Zula (21 sequences were recorded, Tab. 1). Our main topic was to describe and sample sedimentary archives, in order to assess, in a geo-archaeological perspective, the most relevant proxies that could

be analysed along available mid-to-late holocene coastal sequences.

We have identified three main issues: (1) History of the vegetation since 6000 years, (2) Coastal palaeo-geography since 6000 years and (3) History of the fluvial activity in Adulis.

Core	mode de prélèvement	site	Latitude			Longitude			Issue
			°	'	"	°	'	"	
AD-I	manual auger	Galala hills	15	13	1,115	39	41	50,319	Palaeo-island
AD-II	"	Galala hills	15	13	0,74	39	41	50,421	Palaeo-island
AD-III	"	Galala hills	15	13	0,542	39	41	50,341	Palaeo-island
AD-IV	"	Galala hills	15	13	21,4	39	41	42,63	Palaeo-island
AD-V	"	Galala hills	15	13	17,9	39	41	45,4	Palaeo-island
AD-VI	"	Galala hills	15	12	49,42	39	42	25,43	Palaeo-island
AD-VII	"	Galala hills	15	13	3,03	39	41	48,345	Palaeo-island
AD-VIII	"	Galala hills	15	13	18,22	39	41	33,1	Palaeo-island
AD-IX	"	Adulis _ secteur 2	-	-	-	-	-	-	fluvial activity
AD-X	"	Adulis _ secteur 2	-	-	-	-	-	-	fluvial activity
AD-XI	"	Adulis _ secteur 2	-	-	-	-	-	-	fluvial activity
AD-XII	excavation's section	Adulis _ secteur 2	-	-	-	-	-	-	fluvial activity
AD-XIII	manual auger	Adulis _ secteur 2	-	-	-	-	-	-	fluvial activity
AD-XIV	excavation's section	Adulis _ secteur 4	-	-	-	-	-	-	fluvial activity
AD-XV	manual auger	Massor lagoon	15	3	34,76	39	46	30,8	vegetation history
AD-XVI	"	Massor lagoon	15	3	32,01	39	46	28,08	vegetation history
AD-XVII	"	Massor lagoon	15	3	30,6	39	46	27,19	vegetation history
AD-XVIII	"	Massor lagoon	15	3	35,96	39	46	22,86	vegetation history
AD-XIX	"	Massor lagoon	2 m to the east of AD-XVIII			-	-	-	vegetation history
AD-XX	fluvial terrace escapment	Haddas River	15	15	45,03	39	39	54,215	fluvial activity
AD-XXI	"	Haddas River	15	15	52,53	39	40	32,682	fluvial activity

Tab 1 - List and locations of cores and sections studies

Topic 1: History of the vegetation since 6000 years

Massor beach, south of Irafalo village, at the southern edge of the Gulf of Zula, is a typical pocket beach delimited by two rocky promontories. Main sediments sources are two small wadi systems. The geomorphological setting of this site is extremely interesting (Fig. 2). A kilometer long sand spit protects a tidal lagoon characterized by mud deposits and mangrove vegetation. We decided to core in this sector for paleo-climatic and biogeographic purposes. We were able to extract 4 cores down to 6 m depth (core AD-XVIII to ADXIX; Fig. 3). High-resolution sampling of 2 to 5 cm and laboratory analyses will allow to progress on two main topics: (1) Palynological research will give us the possibility to describe and quantify, for the first time in the Adulis area, the evolution of the vegetation since ca. 6000 years (e.g. stabilization of relative sea-level rise). (2) This sedimentary research will help us establish

the late Holocene history of natural climatic variability in coastal Eritrea for the first time, the history of pluviometry, summer monsoon activity (e.g. Camberlin, 1997) and availability of water resources in the area of Adulis.

Topic 2: Coastal paleo-geography since 6000 years

The geomorphological setting of Adulis is characterized by the presence of the delta fan of Alighede river (Fig. 1). Haddas river, presently dammed and dyked, is a secondary branch of this important arid fluvial complex. It is likely that below this fan were previously deposited sediment within a marine environment, because the coastal landform translates a classic progradation process, with an associated marine recession, due to the relative sea-level stabilization and a positive sedimentary budget during the last six millennia.

According to this scenario, the Galala hills in the southern part of Alighede delta fan (Fig. 4),

a series of three hills composed of pyroclastic deposits and vesicular basalt (Alemseged, 2011), isolated within the flat floodplain, would have been islands in more ancient times. This hypothesis was first suggested by Peacock and Blue (2008), based on preliminary sedimentary evidences. Further interpretation led these authors to consider the Galala hills area as a possible harbor area of Adulis in Antiquity.

To further document this hypothesis, we made four cores between Galala hills 3 and 2 (Fig. 4). Cores AD-III, -II, -I and -VII provide a S-N sedimentary transect across the river channel that separated the two hills (Fig. 5). From south to north, the volcanic substrate was found in cores at 1.5, 2.7, 2.3, and 3.1 m below the surface, respectively. Preliminary field observations from sediments deposited above the substrate indicate the presence of possible marine shells fragments within a medium sands matrix. Upper sedimentation is characterized by fluvial sands. Further bio-sedimentology analysis of the base of the cores are currently in progress, in order (1) to confirm the presence of marine or coastal sediments close to the palaeo-islands, and (2) found suitable material for radiocarbon datings which will draw geoarchaeological issue about harbor potentialities of the area in ancient times.

Cores AD-IV and AD-V were made at the north-eastern edge of Galala hill 2, at the foothill of a palaeo-cliff. Core AD-VIII was made just west of the sill that links Galala hills 2 and 1, which has, until now, remained above the floodplain. These three cores display respectively 2, 4 and 3.7 m of fluvial accumulation. Because of the hardness of these sediments, we were not able to reach deeper layers and potential marine sediments.

Cores AD-VI was made east of Galala hills, close to the shores, at the edge of the tidal zone (Fig. 4). In this sector, it is interesting to note that modern fishing boats lie directly within the tidal zone, in the middle of sparse mangrove vegetation. Boats are in dry-dock during low tide. Such configuration suggests that Adulis ancient port was not necessarily protected backward piers or jetties, neither quays were required to load and unload boat's goods. Core AD-VI displays a 4 m sequence of homogeneous, dark grey, tidal to sub-tidal sands and silts. Unfortunately, we were not able to go further depth, because of the hardness of sediment and rapid infilling of the borehole.

Topic 3: History of the fluvial activity in Adulis

The site of Adulis site is located on the Northern side of the Haddas river in a topographical position of an interfluve, probably of anthropogenic origin (i.e. a tell). It is important to note that the majority of the archaeological structures, dating back to the Roman period, are overlain by at least two meters of fluvial deposits since the abandonment of the site in the 7th century AD (e.g. section AD-XII, Fig. 6). This means that the principal geomorphological forcing agent was running fluvial waters (e.g. sheet and rill floods) by episodic flooding events during the winter and summer (active monsoon). We have studied two sections along the western bank of the incised Haddas river (AD-XX and -XXI ; Fig. 7 and 8). Both sections have revealed ca. 4 meters of fluvial sediment accumulation. The detailed description of section AD-XX shows at the base 1.1 m of homogeneous medium and coarse sands deposits. Such a coarse load is likely to have been deposited within the river bed, by analogy with sedimentation in the modern Haddas stream. Upper layers are floodplain deposits, characterized by alternations of silts and fine sands dominated strata, as well as small erosional truncations. The change in depositional conditions from river stream to floodplain translates the lateral shifting of the river bed, a very classic process in river delta. Further examination and comparison of fluvial sections AD-XII, AD-XX and AD-XXI, will include grain size analysis and the establishment of a chronological framework through radiocarbon and OSL datings, as well as archaeological markers (e.g. the funeral amphora found in situ in floodplain deposits at the base of section AD-XXI, Fig. 8). This will initiate an important research thematic focussed on flood hazards and water management in ancient Adulis.

By contrast with the 2 m thick fluvial sedimentation recorded in Adulis since the 7th century AD, the site is now characterized by rapid fluvial incision (gully type; Fig. 9), since ca. 60 years. This fluvial metamorphosis, from major flooding events and sedimentary aggradation, to incision and natural archaeological destruction, is very recent and attested by the presence of Muslim tombs on top of the flooding sequence (the cemetery was still in use in early 20th century AD). These geomorphological dynamics can translate two factors: (1) The local damming and channeling

of the river Haddas. In a way, it is a positive solution because it prevents the site from catastrophic flooding; (2) The climatic aridification of the region since ca. 60 years. Indeed, it can be noted that all the geographical sectors surveyed during our mission between Massawa and Irafalo present important fluvial incision, indicating that the damming of the river Haddas cannot be considered as a single forcing of the downstream river incision. The archaeological consequences of this gully activities are important in terms of archaeological destructions. Some ancient walls and archaeological structures are cut and progressively dismantle by regressive erosion in a soft sedimentary substratum (e.g. silts and fine sands). As a consequence, the East-West talweg, cutting the site in two sectors, appears completely paved by archaeological material (mainly in volcanic material). This accelerated erosion of the archaeological remains is particularly intense in sectors 1, 4 and 5. This erosion can measure 4 m along the Haddas river (Figs. 7 and 8).

Archaeology (C. Zazzaro)

The archaeological survey was conducted with the aim of better understanding the settlement system around Adulis, particularly in relation with harbor and trade activities.

The team had the chance also to visit two sites identified as Samidi north and Samidi south by the Eritro-British team in 2004-5 and an abandoned port site to the north of Irafalo, on the western shore of the Zula Bay.

The Haddas river from Adulis to the coastline

The survey along the Haddas river bed was conducted with the assistance of a local informant, using a Nikon camera with integrated GPS and a Garmin GPS to delimit the areas of archaeological interest.

The first day the survey was conducted along secondary channels of the river Haddas and it did not gave relevant results, while the second and third day the survey focused on the exploration of the main channel, already object of interest in the previous field season, which gave more interesting results.

The survey in the secondary channels started from Adulis and ended on the actual shore, roughly in front of Adulis, while relevant environmental changes were noticed, only very few, scattered and not identifiable sherds were

observed by walking both on the alluvial plain and in the channels.

The survey in the main channel, tracked in Fig. 10, revealed evidence of a possible settlement continuity from Adulis. Surface evidence consisted in clusters of rubble basalt masonry, river pebbles and potsherds, including ribbed Ayla amphorae and local vessels. Three main areas, roughly west-east oriented, were identified to the left and to the right of the river bank. Area A measures ca. 990 sq m, it is located on the right bank, ca. 50 m from the east end of the site. Area B measures ca. 370 sq m, it is located on the left bank, ca. 150m from the east end of the site. Area C measures 8000 sq m, it is located on the left bank, ca. 1200m from the east end of the site.

Area C was particularly interesting because of its extension, the large rubble basalt masonry and for the presence of an amphora burial found in the river sediment wall. The amphora was already observed during the 2014 field season and remained untouched, but this time it was excavated and recovered to prevent its further destruction by floods and erosion. The skeleton found in the amphora corresponded to that of a male infant, 5 up to 12 months old², the original deposition of the body was disturbed by the collapse of one side of the amphora and only part of it was preserved.

The finding of the burial and the distribution and type of evidence along the Haddas suggests at least two possible interpretation: as settlements connected to the exploitation of agriculture around Adulis, or as cemetery, although there are not further evidence to support this hypothesis except for the amphora burial. The delta fan of the Haddas may have represented the most favorable area close to the site for agriculture and would have provided sufficient food supply for the town and provisions for the ships transiting through Adulis.

Galala hills

The investigation of Galala hills were aimed at better understanding their function and their relation with Adulis, how did they function as landing place - as suggested by the Eritro-British team - and for how long they have been used, why and when they were abandoned.

² Alfredo Carannante provided a detailed description of the infant remains.

In order to answer to these questions the team surveyed the hills, focusing in particular on Galala 3, which was the most accessible for security reasons. Here, a systematic survey and a surface collection on a selected area were conducted, a 2x2m test trench was also excavated in order to verify the consistency of the sediment.

The three hills appear artificially flattened on the top. Galala 1 and 2 are characterized by the presence of Ethiopian rifle emplacements from the time of the war. A quick visit to Galala 1 revealed the presence of fine ware potsherds possibly coming from the highlands and dating to the 1st BC-AD.

Galala 3 has a wide flattened area on the top interrupted by emerging rocks and characterized on the whole surface by concentrations of potsherds and shells. At the southern extremity a concentration of stones in a circular position may suggest the presence of a Muslim prayer enclosure. Three vessels half-buried in the ground were also notes, dislocated half-way and on the top of the hill.

A systematic surface collection was conducted on a transect 40 × 4m, roughly half-way on the east side of the hill, in correspondence of a major concentration of shells and potsherds. Collected materials were studied and are currently in course of analysis.

The finding of large quantities of shells also in the excavated trench suggests that Galala 3 may have been employed also for the collection and commerce of highly requested marine products.

To the north of Adulis

The team also visited two cemeteries, identified by the Eritro-British team as Samidi north and Samidi south, a town depicted in the Cosmas Indicopleustes's manuscript, ca. 7.5 and 8Km to the north of Adulis. Our informant also shown us a third cemetery 11Km to the north of Adulis.

The name given by the local informant to the fist mound we encountered is Dom Tselim, which means black hill in Tigré. The burials are in fact distributed around a central mound decorated with reused architectural remains, basalt pillars and capitals. According to the geomorphologists the area, being closer to the sea and at a river mouth like Adulis, may have been covered with much more sediments than Adulis during time, therefore the ancient site from where the architectural remains may come

from, would be completely buried. Further, the presence of a sand bank parallel to the coast suggests the area would not have been suitable for ship to land.

The second site is called Dom Tsa'eda, which means white hill in Tigré, it is characterized by a mound covered with quartz and dressed schist slabs in a circle, with engraved letters. The third cemetery is called by the local informant Dabba Sheikh, which means Place of Sheikh in Tigré. All the burials are roughly west-east oriented and are of unknown dating.

Ancient Irafalo

The team had the chance also to visit an abandoned port site located 4Km to the north of the modern Irafalo village and 18Km to the south of Adulis at the bottom of the Zula Bay. The site was well known by the local inhabitants but it was shown to the team of the Massawa Museum only in 2014 when the site was increasingly been looted.

The site extends ca. 1Km × 500m west-east from the Massawa-Assab road to the coastline. Several large stone structures are visible on the surface. Close to the road a large circular structure with white pebbles or quartz on the top, was noted, which may likely be a burial. Several potsherds were observed on the surface, as well as colored opaque glass bracelets and semiprecious gems that may have attracted the thieves. The pottery assemblage included a large variety of local and imported ware among which, green underglaze potsherds, possibly from Iran and Chinese blue and white porcelain were distinguished.

Preliminary pottery analysis suggests that the site may correspond to the ancient settlement of Irafalo. The name of this port is known in the maps since the 15th c. and in literary sources since the 17th c., losing its importance in the 19th c. (Encyclopaedia Aethiopia 2007, 181-182). The site is of great relevance both for the Eritrean and Red Sea history.

Archaeomalacological remains (A. Carannante)

Shells of mollusks and other invertebrates recovered in archaeological sites supply a double sequence of information. Shells taphonomy may suggest their uses and their role in ancient economies and cultures, while the ecology of the species may supply palaeo-ecological information about the evolution of the local environment, climate and landscape.

The present report is the result of first direct observations made on the archaeo-malacological assemblage from Adulis and Galala in February 2015. The shell samples have been taxonomically identified, their ecology has been verified and taphonomical analyses have been carried on in order to check out marine erosion, bioerosion, biofouling and anthropic marks on them.

The archaeo-malacological assemblage from Adulis consists of 1269 mollusk shell remains (corresponding to 1138 individuals) and 49 coral skeleton fragments. The 98.3% of the mollusk shell assemblage (1247 remains) has been identified at least at Genus level. It pertains to 44 taxa.

Gastropods markedly prevail with 1043 remains whereas bivalves are less represented in the assemblage with only 207 remains. 18 cuttlefish bone remains have been also found (Cephalopoda).

Most of the shells shows a bad state of conservation due to the erosive action of water in the vadose zone of the archaeological deposit and a consequent medium degree of fragmentation. Evidences of predation bores, bioerosion and biofouling are instead very rare.

Among the gastropods, *Cypraea* (cowries) is significantly the Genus most represented with 964 remains (77.3% of the identified mollusk specimens) attributable to several species (e.g. *Cypraea annulus*, *C. caurica*, *C. lamarckii*, *C. moneta*, *C. ocellata*, *C. onyx*, *C. tigris*, *C. turdus*).

271 cowries show one or more holes but most of them are related to natural erosion phenomena and just 19 shells appear intentionally bored to realize ornamental pendant and beads. At least 12 of them show the typical pattern described by archaeo-malacologists as “cowrie lips” ornament. This was obtained by abrading the last whorl of the shell leaving only the inner and outer lips around the aperture. Cowrie lips are a widespread ornament in the Eastern Africa cultures.

The described cowries ornaments are generally fixed to expose permanently the aperture whose symbolism is associated to female sexuality and/or to an apotropaic role.

Other 15 cowrie objects from Adulis are more enigmatic. They consist of a simple small “cup” obtained from last whorl of the shell abrading the lips and the columella. Such kind of object has never been attested in other

archaeological contexts and its cultural role in Adulis has to be further analyzed.

Most of the cowries 896 (93,0%) were found in the “Room C”, Sector 3. 268 cowries from “Room C” show intense non marine erosional marks but they have been found together with very well preserved shells suggesting it is not a post-depositional phenomenon and excluding an ornamental use. Cowrie shells in ancient world were involved with apotropaic and/or sexual symbolisms and were also used as tokens or “money”. The intense erosion of a part of the cowries together with their discovery in chaotic deposits suggest this last hypothesis.

Naticidae with *Polinices mammilla* and *Mammilla simiae* is second gastropod taxon most represented with 14 remains all showing an anthropic bore on the last whorl suggesting an ornamental use. The bores -made by percussion or drilling- were always made next to the shell aperture in order to expose the last whorl.

The same use as bead/pendant is attributable to the 6 *Oliva bulbosa* shells all showing an artificial bore obtained grinding the apex. “*Oliva* pendant” is an ornament typical of ancient Arabic Peninsula. Further analyses will help to check the significance of their presence in Adulis.

Cassidula nucleus, *Tibia insulaechorab*, *Nerita albacilla* and *N. textilis*, *Volema* sp. and *Volvarina amydrozona* shells were also used as ornament at Adulis.

The use of gastropod in the diet at Adulis is less evident. Just few Muricidae, Potamididae, Terebridae and Littorinidae shells may be attributed to alimentary consumption.

Among the bivalves, *Pinctada* (pearl oyster) is significantly the Genus most represented with 169 remains (13.5% of the identified mollusc specimens) due however to the high degree of fragmentation of the remains. Some entire valves have been reconstructed from several fragments found in single stratigraphic units suggesting a post-depositional breakage of the shells.

Pinctada shells are the most important source of mother-of-pearl and pearls but neither pearls nor working marks are attested in the Adulis assemblage. *Anadara* spp. (mainly *Anadara antiquata*) is the second bivalve taxon most represented with 14 remains. Four valves showing an artificial bore in the centre and four intensely worn allow to exclude their role in the diet. *Acrosterigma lacunosa*, *Asaphis violacescens*, *Atactodea glabrata*, *Chama*

pacifica reflexa, *Codakia tigerina*, *Marcia marmorata*, *Pitar* sp. were more likely part of the diet at Adulis.

The archaeomalacological assemblage from Adulis is completed by 49 fragments of Anthozoa coral branches. Some of them are identifiable as Mediterranean red coral (*Corallium rubrum*). The characteristic red color is well preserved in all the remains as well as the dense longitudinal typical *striae* pattern. Further analyses will allow to define their origin and if they can be surely attributed to Mediterranean precious coral. The Mediterranean red coral presence may archaeologically attest important marine resources exchanges between Mediterranean countries and Red Sea/Indian Ocean coasts as reported by *Periplus Maris Erythraei*.

Mediterranean red coral fragments have been found also during the surface survey on Galala Hills. Here large shell remains literally cover some areas due to deflation phenomena and an important archaeo-malacological assemblage has been collected. Considering just a 4 m side square, collected samples consist of 243 shell remains pertaining to 149 individuals (MNI) and 13 taxa. *Chicoreus ramosus* is the species much more represented with 100 remains followed by 89 *Strombus tricornis* and 8 *Volema paradisiaca* remains. *Asaphis violacescens*, *Chama asperella*, *Nerita* sp., *Pinna muricata*, *Plagiocardium* sp., *Protapes* sp., *Spondylus* sp., *Tectus dentatus*, *Tibia insulaechorab* remains are scarcely represented.

The absolute predominance of *Chicoreus* remains in the assemblage suggests a special role for this species in the Galala economy. Nowadays, the importance of this mollusc shell in the region is related to the exploitation of the opercula exported in all the Arabian Peninsula and Persian Gulf to produce the so called “zephir” an important ingredient for incense. Future excavations in the site will allow to reconstruct the exploitation of marine resources in ancient Galala.

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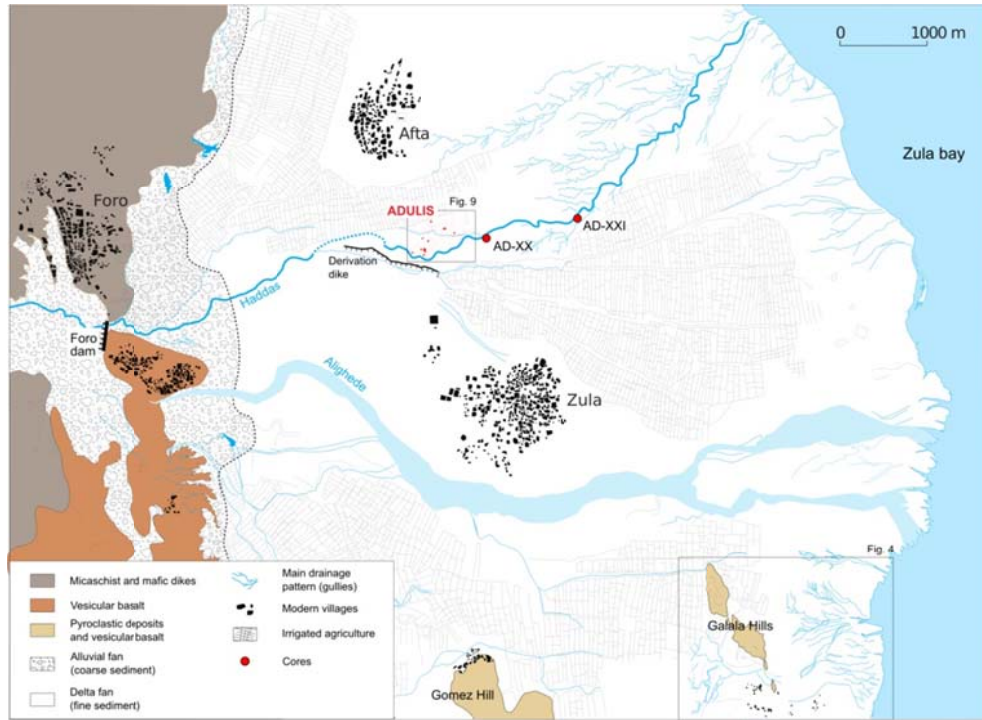


Fig. 1 - Main geo-morphological features of the Alighede-Haddas delta fan, alongside the western bay of Zula (CAD Patrick Pentsh, Aix-Marseille university; Geological unit after Alemseged, 2011)

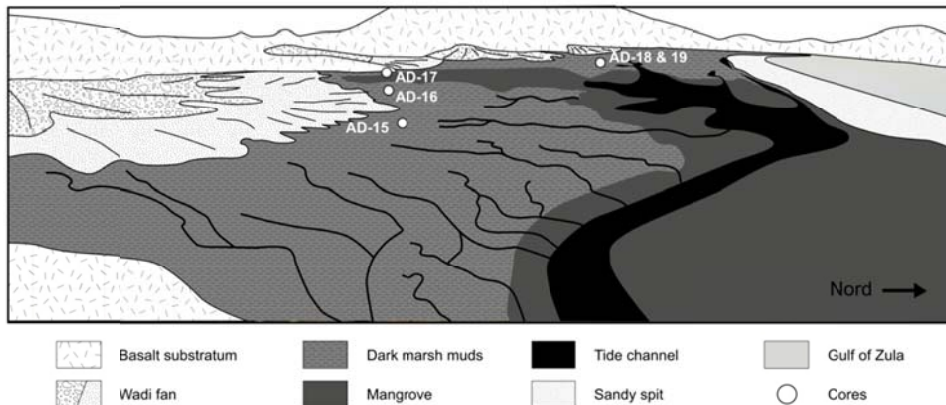


Fig. 2 - Geo-morphological sketch of Massor beach and lagoon in the southern Zula bay

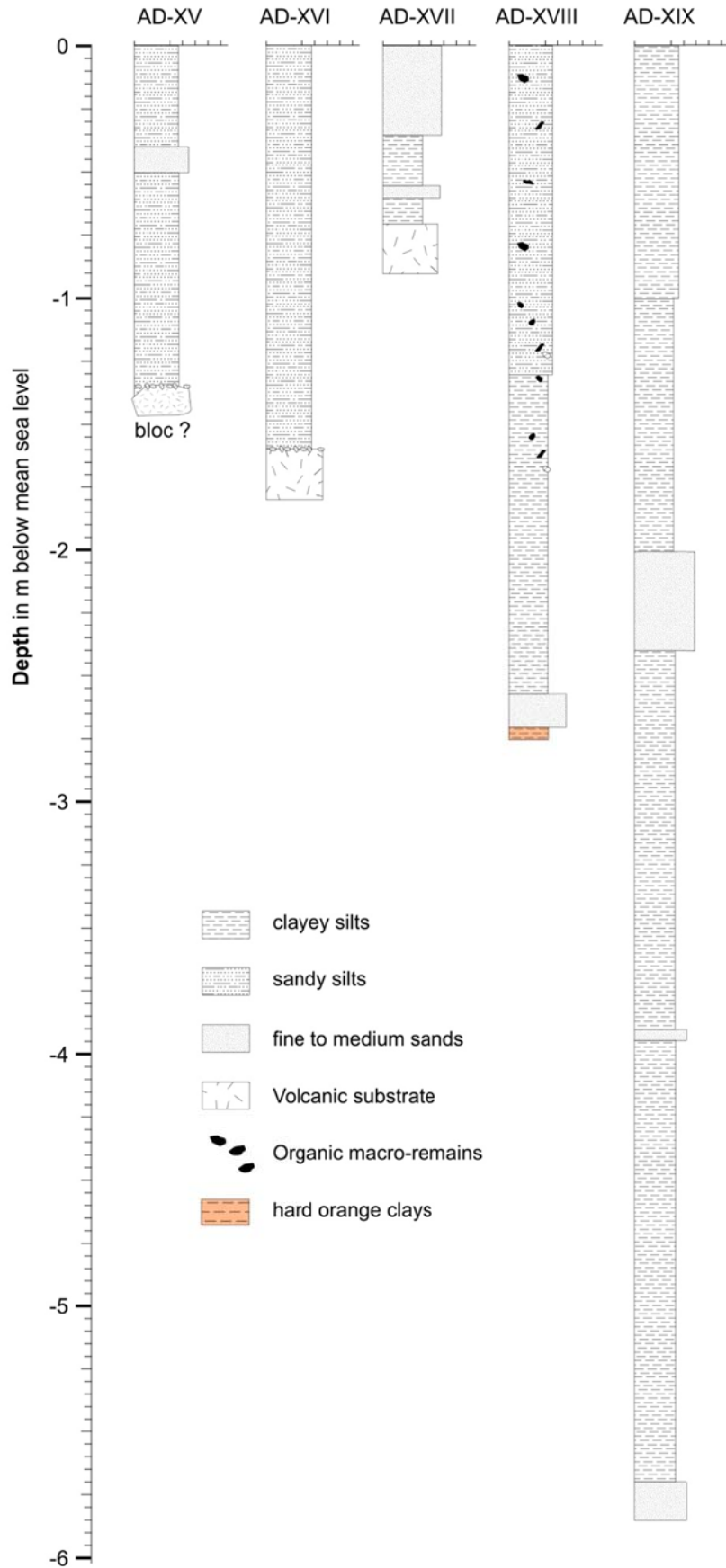


Fig. 3 - Sedimentary log of cores AD-XV, AD-XVI, AD-XVII, AD-XVIII and AD-XIX, Massor lagoon, southern Zula bay

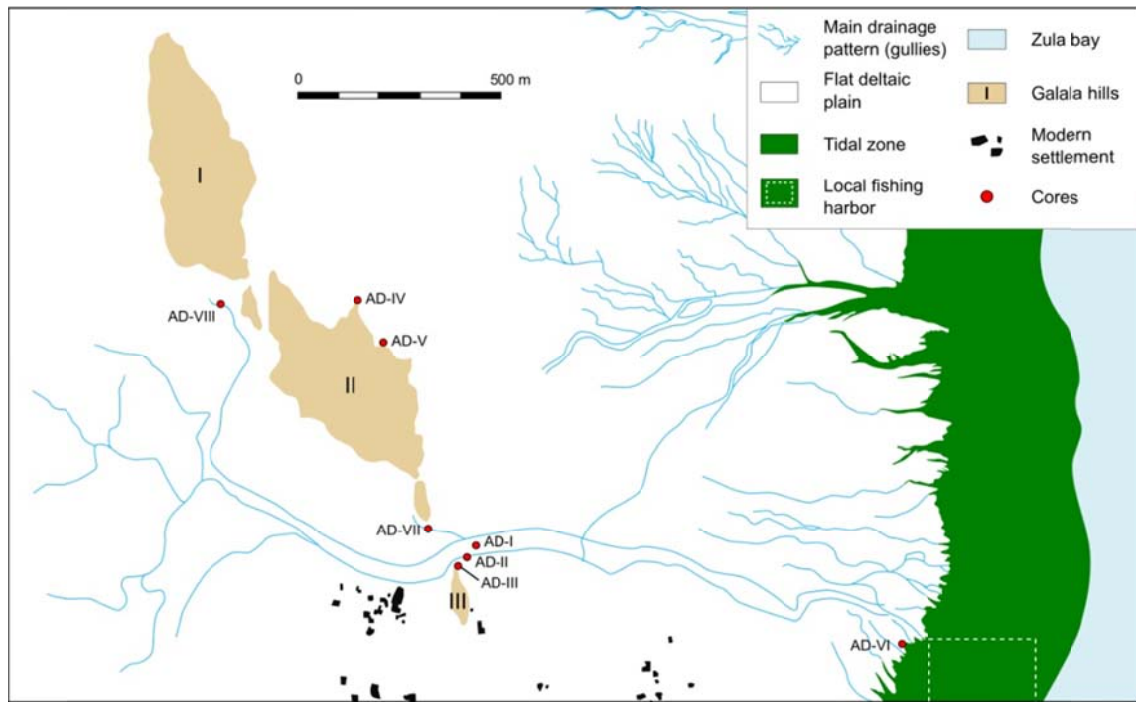


Fig. 4 - Geo-morphological map of the Alighede river delta in the area of Galala hills

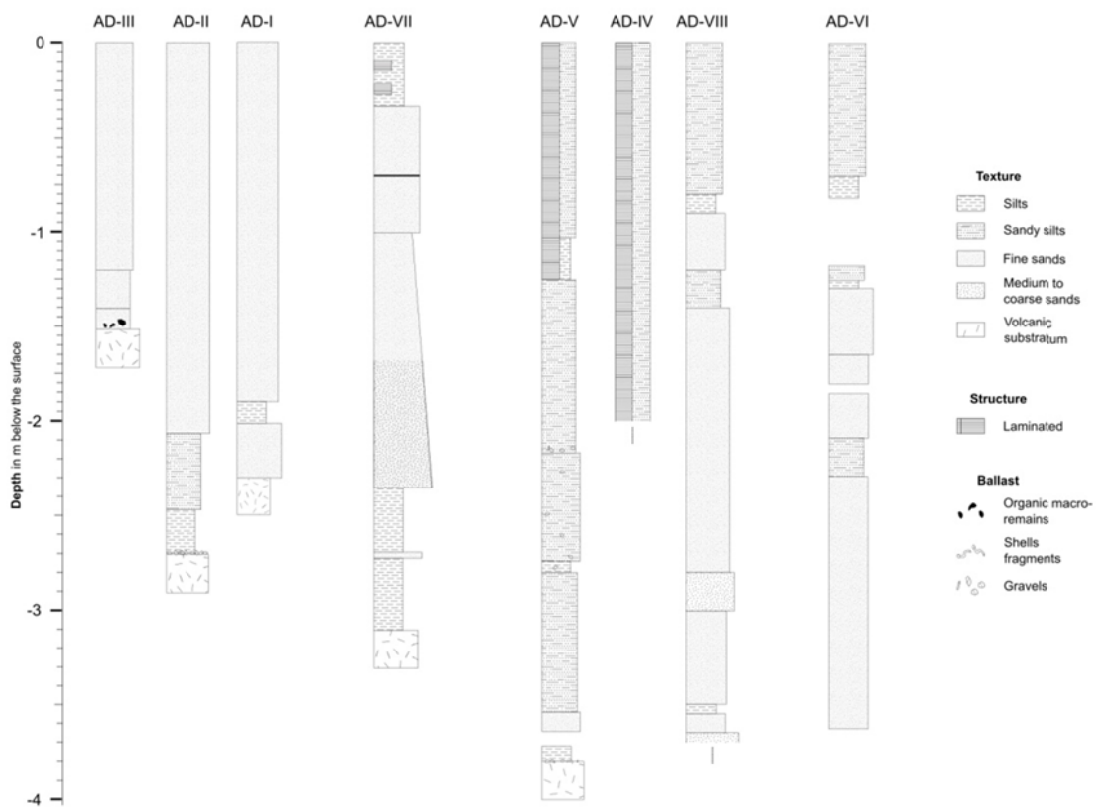


Fig. 5 - Sedimentary log of cores AD-I, AD-II, AD-III, AD-IV, AD-V, AD-VI, AD-VII and AD-VIII, Alighede river delta, sector of Galala hills



Fig. 6 - Sedimentary log AD-XII, measured and described from the western section of sector 2 in Adulis

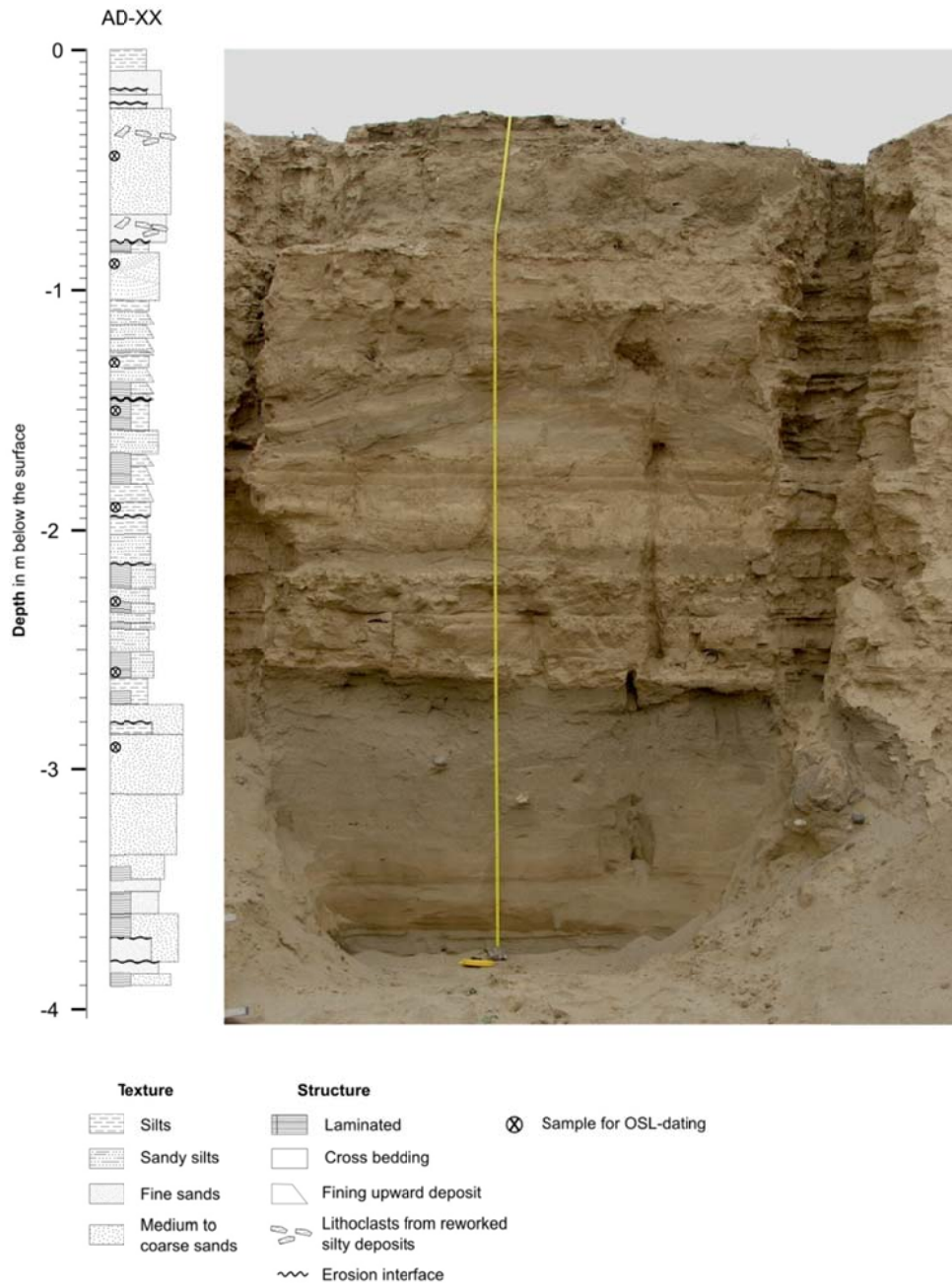


Fig. 7 - Sedimentary log AD-XX, measured and described from the southern bank of the Haddas river, east of Adulis

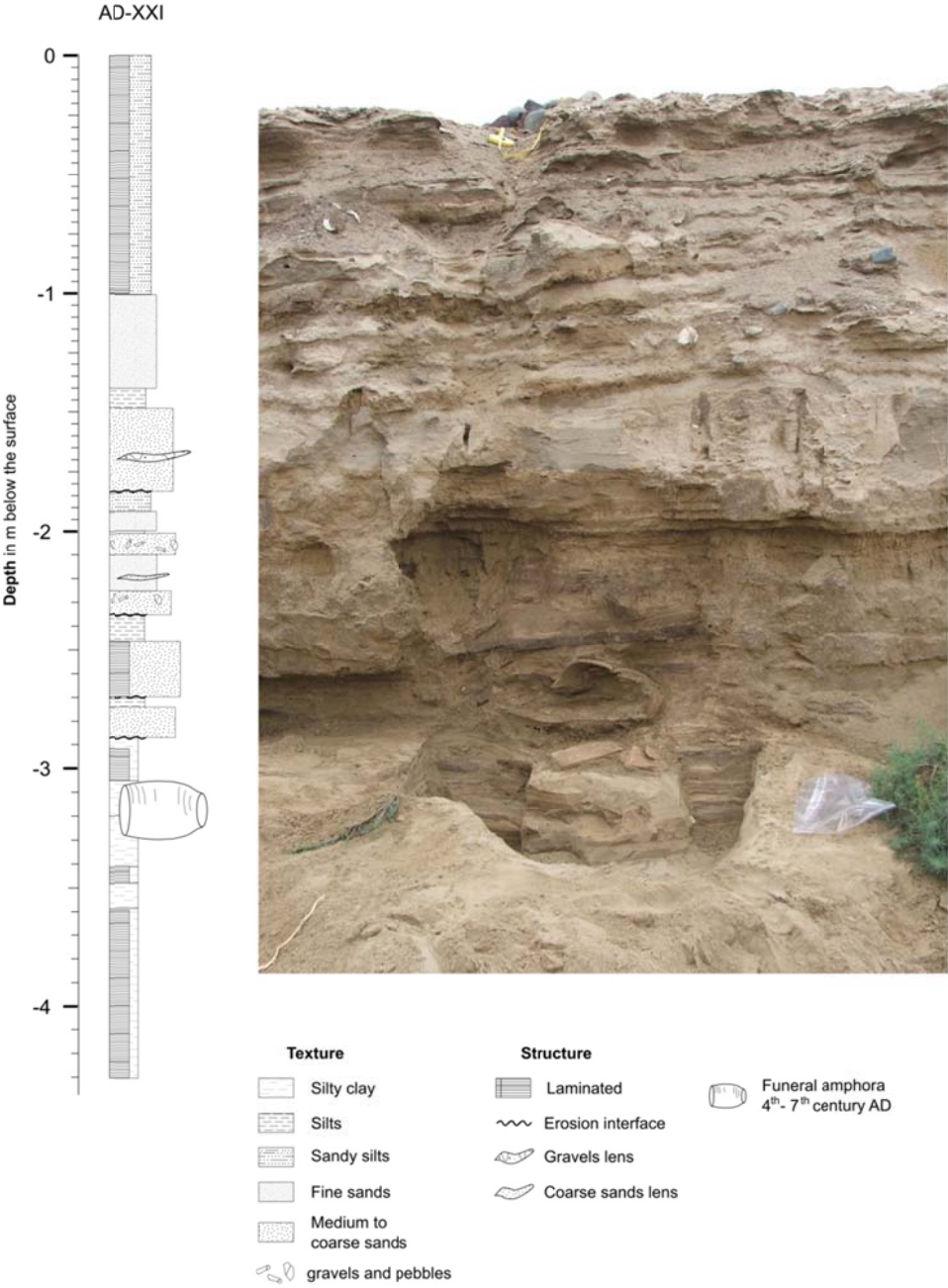


Fig. 8 - Sedimentary log AD-XXI, measured and described from the southern bank of the Haddas river, ca. 1 km east and downstream from AD-XX

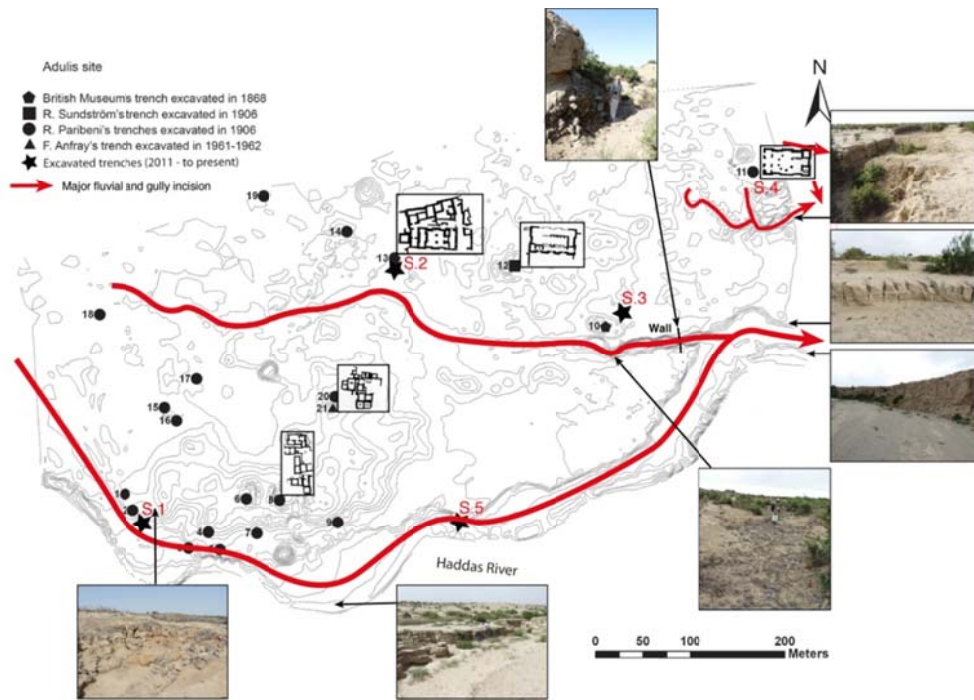


Fig. 9 - Fluvial risk map of ancient Adulis due to modern gully incision. Topographic map after Bigliardi *et alii* (2013).



Fig. 10 - Areas A, B and C surveyed to the left and right banks of the Haddas, to the east of Adulis