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Geoarchaeology of Phoenicia's buried harbours: Beirut, Sidon and Tyre 5000 years of human-environment interactions

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Using earth science and archaeological tools, we investigate 5000 years of human-environment interactions at Beirut, Sidon and Tyre. All three sites grew up around easily defendable pocket beaches during the Bronze Age. Medium grain sand units and concomitant coastal faunas are concurrent with the predominance of environmental determinism at this time. Towards the end of the Bronze Age and early Iron Age, expanding Mediterranean exchanges and developments in naval architecture entrained artificial modification of the natural anchorages. Although Roman and Byzantine dredging has paradoxically created archiveless Iron Age harbours, fine-grained sediment pockets at Sidon and Tyre evoke advanced harbourworks at this time. We record significant changes in the spatial topography of all three harbours during the Roman period. Persistent age-depth anomalies and sediment hiatuses are consistent with pronounced harbour dredging at this time. The Roman seaports of Beirut, Sidon and Tyre are characterised by fine silty sands with a marine lagoonal fauna. The harbours' apogee is recorded during the Byzantine period, comprising a plastic clay with lagoonal and marine lagoonal faunas. The relative demise of Phoenicia's harbours is centred on the sixth to eighth centuries AD. We attribute this to three complementary dynamics: (1) historical, namely the retraction of the Byzantine empire to its Anatolian core; (2) rapid relative sea-level changes linked to coastal neotectonics; and (3) tsunamogenic destruction of harbour infrastructure.

At Tyre, we elucidate a three phase morphogenetic model for the Holocene evolution of the city's tombolo. The area's geological record manifests a long history of natural morphodynamic and anthropogenic forcings. (1) Leeward of the island breakwater, the Maximum Flooding Surface (MFS) is dated ~7500 BP. Fine-grained sediments and brackish and marine lagoonal faunas translate shallow, low-energy waterbodies during this period. Shelter was afforded by Tyre's elongated sandstone reefs which cumulatively acted as a shore-parallel breakwater. (2) After 6000 BP, sea-level stability and high sediment supply engendered medium to fine grained sediment deposition on the lee of the island barriers. This culminated in a natural wave dominated proto-tombolo within 1-2 m of MSL by the time of Alexander the Great (4th century BC). (3) After 332 BC, construction of Alexander's causeway entrained a complete anthropogenic metamorphosis of the Tyrian coastal system.

One of the major challenges facing cultural managers in the Mediterranean is linked to precisely assessing the scope of historical resources in coastal areas. Within the context of the 2001 UNESCO convention on the Protection of Underwater Cultural Heritage, it is hoped that this work will help to underline the importance of an applied geomorphological approach in helping to identify areas of sensitive archaeology, both on land and in near-shore areas.



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