



## A SATELLITE SURVEY OF EL-MARKHA PLAIN AND BEYOND: SEARCHING FOR ADDITIONAL POTENTIAL PHARAONIC FORTS<sup>1</sup>

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### ABSTRACT

*Discoveries from the past 15 years along the Red Sea in Sinai and Egypt have shown just how much remains to be found in an area previously overlooked by many Egyptologists. The excavations and findings at an Old Kingdom fort at Ras Budran and an anchorage and associated complex of sites at Wadi al-Jarf emphasize that there may be additional features to locate. By applying Google Earth Pro to this search, which contains imagery at a resolution of 50 cm, a series of potential additional fort sites have emerged for future assessment. In Sinai and Egypt, however, rapid urban and rural development has made such searches urgent, before these sites are affected by new construction. In the Sinai, which is currently off bounds to most archaeological work, Google Earth Pro provides the best possible tool for conducting surveys prior to the restoration of security and resumption of survey and excavation in this region.*

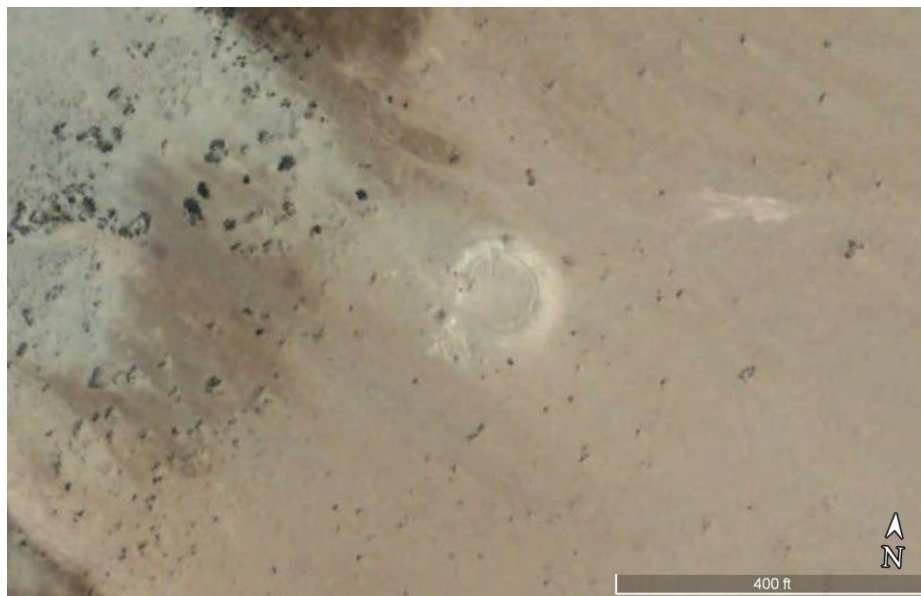


Figure 1: Tell Ras Budran, satellite image taken in early 2003, post first season of excavations. Note the slightly cleared and exposed uppermost part of the wall system and the western trench (Imagery courtesy of Google Earth Pro)

### INTRODUCTION

In Egyptology, satellite remote sensing is playing an ever-increasing role in the discovery and management of archaeological sites.<sup>2</sup> This is primarily due to the significantly lowered costs of

high resolution satellite imagery, and usage of this imagery should increase in future with the recent free release of Google Earth Pro. Google Earth data, which contain high resolution images from multiple times of the year, offer the means to capture subsurface architecture and other substantial features in a

combined surface soil matrix of sand and silt, especially during the wet season (*i.e.*, December through March). Multiple sites in the Egyptian Delta display visible traces of subsurface, ancient cultic installations, large public or administrative buildings, housing areas, streets, and other structures during optimum conditions of higher soil moisture content, whereas such features remain mostly obscured and even “invisible” during drier conditions for the remainder of the year, or even in the wet season once a given site dries out. Hence, selecting satellite imagery from both the optimum season and a specific time during periods of relatively moist to wet conditions form a crucial first step before ordering satellite data since it will affect seriously the success or failure in detecting subsurface sites and features. This study highlights such considerations, their influence, and the findings in the search for a reported second circular structure, and possibly another pharaonic fort, in El-Markha Plain (Southwest Sinai) and elsewhere in this region of the Red Sea.<sup>3</sup>

#### PROBLEMS AND METHODOLOGY

Desert sites can present both additional challenges and opportunities for assessment regarding satellite imagery data. The simple and basic application of satellite images to make visual identifications of features such as ancient roads, pathways, settlements, temples, mastaba tombs, hut circles, cairns, and forts may frequently be clear –especially with high resolution imagery. In some cases, however, especially in more ambiguous circumstances, caution is advised. For instance, ground

verification surveys often reveal that features such as natural rock formations or other forms (including recent, human engineered features) can deceive the mind and eye into interpreting the visual form as an ancient-recent man-made feature versus a natural “artifact.” On the other hand, one may also find promising features in areas devoid of geological formations, where human-made or -altered sites will frequently stand out quite clearly. Since desert regions are usually quite vast, inhospitable, and lack easy access (*i.e.*, modern roads), the coverage provided by aerial photographs and satellite imagery/maps becomes even more crucial for surveys attempting to reduce a huge terrain into a much more manageable set of potential ancient target areas (*i.e.*, sites) for subsequent ground survey and verification.<sup>4</sup>

#### EL-MARKHA PLAIN AND THE RED SEA REGION

In the case of El-Markha Plain, the area sports numerous, small coastal sand dunes, dense clusters of thorn bushes (often covering the coastal sand mounds), a network of multiple, shallow wadi beds extending across the plain to the sea, and modern construction, including tarmac roadways, vehicle tracks, enclosures, isolated buildings, clusters of buildings, a Bedouin village (Kilo Tisa), an oil refinery (SUCO), the town of Abu Rodeis, a small airport, and traces of older and often abandoned structures, docking facilities, and other debris from the past century or so of development in this plain. The late Old Kingdom fort at Ras Budran also appears quite clearly in recent satellite image data as a circular stone structure, 44 m in diameter, with a



Figure 2: Tell Ras Budran, satellite image taken in 2010, with only the easternmost 1/3 of the structure left to excavate. The angle at which the satellite image captured this structure gives a sense of the height of its preservation (Imagery courtesy of Google Earth Pro)



Figure 3: A likely gun emplacement in El-Markha Plain, from the late 1960s Egyptian-Israeli conflict (Imagery courtesy of Google Earth Pro)



Figure 4: A potential additional fort structure 3.3 km south of Ras Budran in El-Markha Plain (Imagery courtesy of Google Earth Pro)

partly excavated interior courtyard and western projecting wall/bastion (Figures 1–2). Local Bedouin led us to this site in 2002, when we began our initial investigations of Tell Markha (Rothenberg site 346),<sup>5</sup> with follow-up excavations at Ras Budran (site 345) in 2004 and 2008. The first visit to the site confirmed that it represented Rothenberg’s 1967 “site 345.”<sup>6</sup> At the time, the Bedouin also mentioned a similar structure, and perhaps another late Old Kingdom fort, located somewhere further to the South, perhaps either within the Suco Oil refinery, or further south towards Abu Rodeis (Figure 8, map). Although it was not possible to conduct a direct survey inside this oil refinery or other compounds to the south, Google Earth Pro provides excellent coverage for the whole of El-Markha Plain. In contrast, other desert areas do not always have such good high resolution coverage. In addition, the recent findings from Ras Budran suggest that the ancient Egyptian expeditions abandoned and began to dismantle the fort soon after investing a substantial amount of time and effort in building this structure, thereby begging the question where might they have taken the stone work from the fort. It would be one thing to abandon the fort and let time and subsequent persons re-use or dismantle it, but the surviving evidence seems fairly explicit, namely that late Old Kingdom expeditions returned to the fort within a few years of its last usage and began dismantling it, using Egyptian-type hammer stones, pottery, and other material culture, and transferring the stone elsewhere.<sup>7</sup> Thus, we began to search systematically for other potential ancient structures, including, and perhaps especially, circular features like the fort at Ras Budran, starting first along the Red Sea coastline, and then moving inland in blocks from East to West.

The first “circular feature” lay approximately 3 km south of Ras Budran, appearing in the interior of the SUCO oil refinery’s massive enclosure, in an area closer to Abu Rodeis. The potential feature measures 12 m wide, with a blackened interior and inward sloping walls (Figure 3). In addition, a series of sixty rectangular, buried shapes, that are each less than 1 by 1 m in area, lie to the west of the circular, ring-shaped feature. However, given the particular diameter, form, specific appearance, and the preservation of this feature, it does not appear to be ancient, but rather a probable old gun emplacement, perhaps dating as far back as the late 1960s through 1970s, while the rectilinear features might reflect associated tent platforms or some other remains of activity in this region. Although this feature was quickly dismissed as a candidate for an ancient site, its superficial similarity deserves mention since 12 m diameter sand rings (i.e., probable defensive gun installations)<sup>8</sup> are fairly common, if not numerous, along both sides of the Red Sea. In fact, modern features are often mistaken for potential ancient ones in satellite imagery analysis where the resolution may be insufficient to discern enough details to determine whether or not a given site may be worthy of surface reconnaissance.

A second feature lies 3.3 km to the south of Ras Budran and displayed a 20 m diameter with a 5 m wide embankment base (Figure 4). This circular ring lay 183 m west of the Red Sea coastline, like the fort at Ras Budran, which lay about 210–225 m from the modern shoreline. The immediate environs of this circular feature lacked spoil heaps and vegetation, and does not seem to be a recent construction. Although it is less than half the diameter of the late Old Kingdom fort at Ras Budran, its dimensions do still fall within the range found for small pharaonic

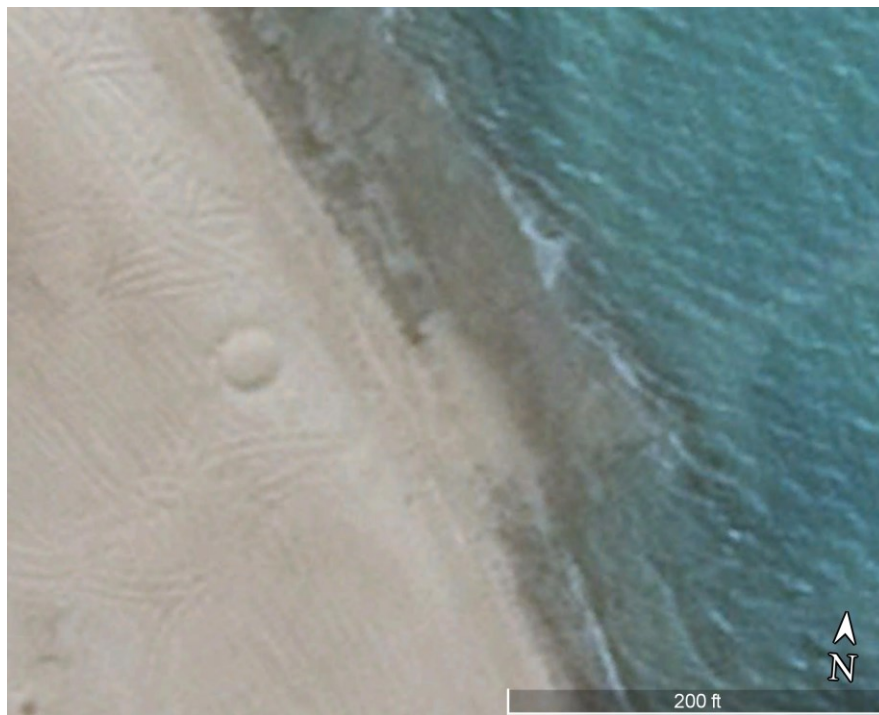


Figure 5: A Likely gun emplacement near Wadi al-Jarf (Imagery courtesy of Google Earth Pro)



Figure 6: Large potential ancient structure in Red Sea region outside El-Markha Plain (Imagery courtesy of Google Earth Pro)



Figure 7: 3D view of potential ancient structure in Red Sea region outside El-Markha Plain (Imagery courtesy of Google Earth Pro)

forts, albeit in an unusual circular form versus the predominant square to rectilinear forts used throughout the Early Dynastic through Late Period (ca. 3000 – 332 B.C.).<sup>9</sup> Could this be the second “similar structure” that our Bedouin sources have described to us? To-date, no other features in El-Markha Plain yield a resemblance to the fort at Ras Budran. It is possible, however, that the significant modern construction work noted over the past 10 years or more may have obscured or destroyed any additional potential archaeological surface features, but this second, smaller circular feature certainly merits future ground verification once archaeological access to Sinai is permitted. Since Rothenberg’s 1967 Sinai survey, and a few subsequent surveys in the 1970s,<sup>10</sup> archaeologists have mostly neglected surveying the coastline of Southwest Sinai,<sup>11</sup> while the current turmoil in the area and temporary cessation of much archaeological work in Sinai makes satellite-based surveys even more important for isolating potential archaeological site for future assessment and protection.<sup>12</sup>

In examining areas outside El-Markha Plain, however, this writer has found a quite promising, third circular site 100 m from the Red Sea. The circular feature is very large, measuring 140 m in diameter, with a 28 m wide embankment (at its base), and a more recent (?) breach, or trace of an entry, along one side (Figure 6). Although we are currently applying for a brief survey season to assess both the period and nature of this structure, alongside the other aforementioned potential features/sites, one is struck by the seemingly mostly untouched environs around this circular feature, including a significant number of camel thorn bushes and a relatively pristine desert surface (i.e., which take time to grow and/or revert to a more natural state). It does display some foot paths and modern vehicle tire tracks and thereby modern human visitation (Bedouin?; others?), but it is otherwise devoid of obvious traces of bulldozing, it lacks tracks from military or other heavy vehicles, or tracks/roads leading to it, and it seems fairly promising in comparison to other modern circular features that are associated more directly with distinct traces of human activity and construction. One is also struck by the substantial size of this feature in contrast to the various structures noted at Ras Budran (i.e., 44 m diameter fort) and Wadi al-Jarf on the opposite side of the Red Sea. The elevation of the feature’s ring embankment is also sufficiently high to be detected by the NASA SRTM data in Google Earth Pro (Figure 7), which suggests that the overlying sand rises at least several meters above the surface. It is not clear if a stone wall might underlie this ring-enclosure (some shadows are suggestive of subsurface blocks/stones), and it lacks an obvious buttressing or other built architectural features. However, the Google Earth Pro visual observation is only a first step, and represents only a tiny fraction of what it is possible to do with satellite remote sensing analysis. While awaiting a ground visit to the feature, we will try various more advanced techniques of satellite remote sensing to see what other clues might emerge regarding its nature.

In looking across the Red Sea directly opposite Ras Budran, at the region around Wadi al-Jarf, a few other potential structures appear. In this region, a French expedition has already used Google Earth quite successfully to locate other aspects of a recently explored Old Kingdom anchorage and affiliated structures at Wadi al-Jarf,<sup>13</sup> confirming the applicability and great potential of Google Earth for aiding desert survey and other arenas in Egyptian archaeology. Of note, this writer did observe an additional 12 meter circular structure near Wadi al Jarf, which appears to be a modern abandoned gun emplacement (Figure 5), paralleling similar circular installations along the Red Sea coast and in El-Markha Plain. However, more advanced satellite remote sensing techniques, such as multispectral analysis, in this and other regions along the Red Sea may yet reveal additional unknown and little known archaeological features.

#### FUTURE APPLICATIONS OF SATELLITE REMOTE SENSING IN SINAI AND THE RED SEA REGION

What does the future hold for satellite remote sensing and detection of potential features in Sinai and along the Red Sea? At present, the best, commercially available satellite imagery resolution is restricted to 40 cm. However, with the recent launch of WorldView-3 and its resolution of 30 cm, plus its ability to detect features in the middle infrared, this imagery promises to uncover many more previously unknown and hard to define archaeological features. In addition, the future promises the launch of even more advanced satellite systems with even better resolutions, more extensive coverage, and the ability to see in the thermal infrared, which is a key part of the electromagnetic spectrum for seeing buried walls on archaeological sites.<sup>14</sup> But, we are racing against time along the Sinai and Red Sea coast, where satellite imagery and ground visits reveal an ever accelerating pace in industrial and commercial development, including the construction of resorts, villas, winter homes, shopping centers, and many other installations that are destroying or obscuring otherwise unknown or little known components of the archaeological heritage of this important region –despite the valiant efforts of the Ministry of Antiquities and other missions.<sup>15</sup>

At present, scientists can download satellite images and 3D models of landscapes onto their iPads for use during surveys. These data can be applied to find the most direct and/or most easily navigated paths to known ancient mining and quarry sites, while predictive models might suggest the probable features for storage caves or buried features.<sup>16</sup> Additional mining sites might be located using hyperspectral analysis, which can be “surveyed” virtually overlaid atop point cloud LIDAR data (to create 3D models) prior to surveying seasons. There are also new tools to locate shipwrecks using high resolution satellite data, which likely are very well preserved beneath the Red Sea. These are new models, and have not yet been fully published, but show that there is much to find in Sinai that may help to rewrite the history of this important area.

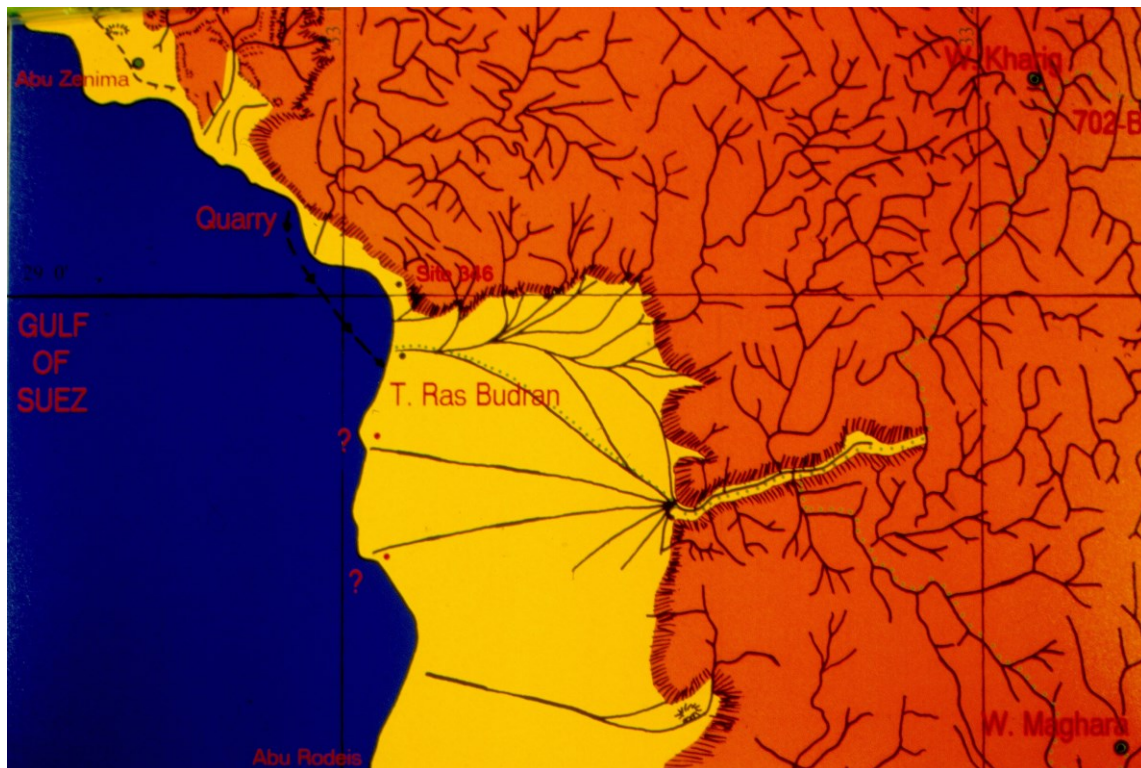


Figure 8: Map of the northern part of El-Markha Plain, including a potential “quarry” and Abu Zenima to the north, with two suggested potential locations for additional anchorages toward Abu Rodcis (map courtesy of G. Mumford, 2012)

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## NOTES

- <sup>1</sup> This writer would like to thank Dr. Zahi Hawass, the Cairo, Suez, and Abu Zenima offices of the Supreme Council of Antiquities (SCA, now renamed the Ministry of Antiquities), the American Research Center in Egypt, the University of Toronto, the University of Alabama at Birmingham, the Markha Plain project (directed by G. Mumford; funded by SSHRCC), Mustafa Rezk (formerly SCA chief inspector with the Markha Plain mission), Reis Omer Farouk (Luxor), Adel Farouk (Suez), the Bedouin workmen and Reis Ayad of Kilo Tisa, and various government, institutional and private funders whose support of the El-Markha Plain project aided this writer in her preliminary work within this region. In addition, special thanks go to Gregory Mumford for his aid in editing and looking over this article, both in his capacity as guest editor of this issue of *JAEL* and as project director of the El-Markha Plain project. This author would also like to thank the National Geographic Society, where she is currently an Archaeology fellow, and adds that she directs related and other satellite remote sensing projects as the CEO of Spectral Globe Technologies.
- <sup>2</sup> Stern and Abdel Salam 1996; Hillier et al. 2007; Parcak 2010; Redmount 2015.
- <sup>3</sup> Reis Ayad and the Bedouin workmen from the village of Kilo Tisa report the existence of a similar structure to the late Old Kingdom fort at Ras Budran, saying that it lies further south and closer to Abu Rodeis. Regarding a preliminary search of El-Markha Plain and the findings at Ras Budran, see Mumford and Parcak 2002; *idem* 2003; Mumford 2006; *idem* 2012a; *idem* 2012b; see also the report on Ras Budran in this issue of *JAEL*. The initial searches to re-locate this similar structure proved futile, and Reis Ayad was unable to direct us to the specific location. It is possible that the structure lies within one of the various restricted compounds that lie in various places in El-Markha Plain.
- <sup>4</sup> Knisely Marpole 2001, 33–37.
- <sup>5</sup> Mumford and Parcak 2003; see also [www.deltasinai.com](http://www.deltasinai.com).
- <sup>6</sup> Rothenberg 1970: 25–27, sites 345–346.
- <sup>7</sup> Personal communication from G. Mumford; see also Mumford 2012a-b; Mumford article in this issue of *JAEL*.
- <sup>8</sup> A preliminary perusal of online sources and images regarding the design and application of artillery

emplacements reveals that it is quite common to make circular and other forms of earthen/sand defensive embankments around short-term through long-term, coastal artillery positions, while modern, direct observations concur that such circular installations continue to be common in desert regions (personal communication from G. Mumford). Naturally, the actual diameters of such circular defensive sand embankments coincide with the individual size of the artillery piece: 12 m appears to be a common diameter for circular defensive rings.

- <sup>9</sup> See Monnier 2010; Vogel 2010; Mumford 2013, 2727.
- <sup>10</sup> Beit-Arieh 2003.
- <sup>11</sup> A French mission conducted a brief survey in the northernmost part of El-Markha Plain, with a visit to Albright's pharaonic "seaport" (Field 1948; Rothenberg 1970, site 346) and visited the area of the slag heaps noted by Petrie at Seih Baba at the eastern edge of El-Markha Plain (see Petrie 1906, 18–19), but mostly concentrated inland in the turquoise and copper mining region (Chartier-Raymond, M., B. Gratien, C. Traunecker, and J.-M. Vinçon 1994).
- <sup>12</sup> In a brief, half-day foot survey along the southern part of El-Markha Plain, to the south of Abu Rodeis, we did not locate additional potential fort structures, but we did find small vegetation covered sand mounds and other raised areas that resembled tumuli and may repay some additional investigation. In examining parts of this region a bit more closely in summer 2002, we did locate grinding stones, a granite basin, and various stone tools (Mumford and Parcak 2002; *idem* 2003). Given the density of the potential tumuli and scattered artifacts, future survey and potential excavation is highly recommended in this area (see Mumford's report on work in Markha Plain in *JAEL*).
- <sup>13</sup> Tallet 2012; Marouard and Tallet 2012, 40–43.
- <sup>14</sup> Parcak 2009.
- <sup>15</sup> Officials and colleagues in the Cairo, Suez, and Abu Zenima offices of the Ministry of Antiquities, and elsewhere, have urged both the Egyptian and foreign governments and missions to aid in conducting surveys, excavations, and conservation work in the Red Sea, Sinai, and other regions of Egypt. The threat to this archaeological heritage is not one limited to Egypt, of course, but is present and increasing across the globe in conjunction with fast-paced and exponentially growing urban and rural development.
- <sup>16</sup> Renfrew and Bahn 2012, 82–9