Onshore drilling in Kefalonia – 2011 Interim Research Summary

Issued 13 February 2012

Project Background:
The objective of the current geoscientific research is to test the proposition that the island of Ithaca may have been accurately described in Homer's *Odyssey* as the furthest west of a group of four islands off the western coast of Greece, facing the open sea and of low elevation.

In 2005 Cambridge University Press published "Odysseus Unbound: The Search for Homer's Ithaca", written by Robert Bittlestone with James Diggle, Professor of Classics at Cambridge University, and John Underhill, Professor of Stratigraphy at Edinburgh University. The book explored the descriptions provided by Homer in the *Odyssey* and also a later reference by the geographer Strabo that described a partially submerged isthmus at the narrowest part of the island.

If this isthmus (now called the Thinia valley) was formerly submerged then the western peninsula of Kefalonia (now called Paliki) would have been a free-standing island in its own right, thereby fitting Homer's description accurately.

Research Sponsorship:
After initial field studies and the successful drilling of one onshore borehole in 2006, research sponsorship for the project was announced in March 2007 from Fugro (provider of geotechnical, survey and geoscience services) under the direction of Professor Underhill. Over the last few years, a number of land, sea and airborne geoscientific techniques have been used to investigate the Thinia isthmus and surrounding areas with the aim of determining the nature of the geology that lies buried below the valley. The results of the work to date have been published in various professional journals and are also available at the Research pages of the project website, www.odysseus-unbound.org

2011 Interim Activity Summary:
During 2011, the project sponsors Fugro acting upon the advice of Professor Underhill have performed land-based shallow (less than 100m) drilling using a small mobile rig. That drilling program has enabled continuous rock-cores to be obtained at a number of locations in Kefalonia, mainly in the Thinia valley. The core samples were transported to Fugro's geospecialist labs in North Wales in late 2011 and are currently being logged, sampled and analysed.

Drilling rig on site in the Thinia valley

Whilst it will take further time for the overall results to emerge, some of the preliminary indications are of particular interest, as follows:

* Borehole cores from the Thinia valley indicate that some very large in-situ rock segments of Cretaceous and Paleogene age period overlay (i.e. have been thrust on top of) rock segments of the younger Plio-Pleistocene period. This confirms that the pre-existing sidewalls of the Thinia valley have themselves been translated westward as a result of relatively recent co-seismic activity. This result represents a “tectonic” disruption of the Thinia valley.

There is further slope instability due to the steep dip of bedding planes on the eastern side of the valley and evidence of further westward translation of the hillside due to gravity-driven rotational landsliding. The tectonic structural deformation is additional to and distinct from the former proposed “sedimentary” mechanism involving only rockfall derived from the higher valley sidewalls (see below for further details).

Further tests will be conducted to assess whether the tectonic movement has also involved up-thrust of a former Holocene seabed (deposited in the last 10,000 years) contained within a marine channel, and radiocarbon and biostratigraphic analyses will shortly be performed to determine whether this may have been the case or not.

Core sample for analysis

* On the south-west flank of the Thinia valley in an area called Katachori, there is clear evidence that a major rockfall has originated from the eastern slopes of the valley, travelled across the valley floor and has come to rest (onlap) upon the upwards-sloping western hillside, infilling the valley itself in the process. This can be confirmed on site and via helicopter-based LIDAR scans, and it is also visible via Google Earth imagery.

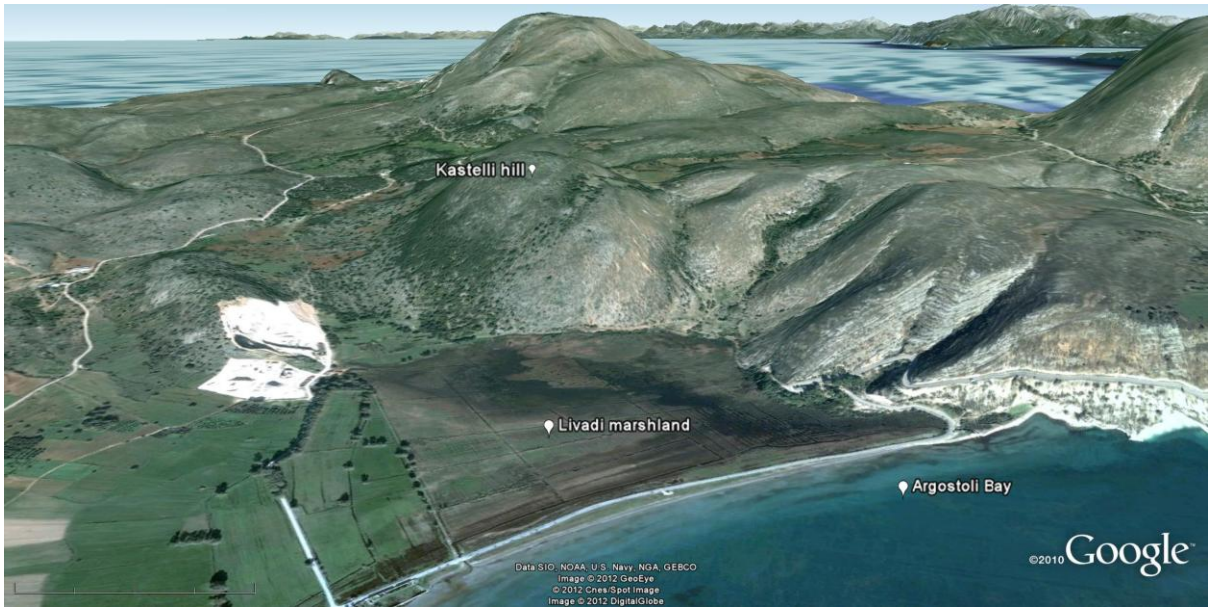
Rockfall from eastern slope infills valley and onlaps western hillside
(image copyright Google Earth)

The tail end of the rockfall has covered some pre-existing walls which end abruptly at the debris and their continuity can be identified underneath it. Upthrust combined with rockfall and valley fill set up a barrier for drainage that caused an ancient lake to form subsequently above it. The lake bed has now silted up and forms a low-agricultural plain in the centre of the valley.

* Elsewhere in Thinia the drill-core samples indicate that rockfall debris covers former marine beach deposits (e.g. at Zola on the north-western end of the valley) and work is ongoing to determine the age of the buried sediments.

Rockfall debris covers former marine beach deposits at Zola
(image copyright Google Earth)

* At the Livadi marshland at the head of Argostoli Bay, core samples from three boreholes indicate that marine ingress and beach deposits occurred up to the base of the Kastelli hill. One of the priorities of the ongoing program is to date these sediments, but the cores already confirm that at some point the sea transgressed up from the Gulf of Livadi to this point to form a deep natural harbour.



Marine ingress and beach deposits in core samples at base of Kastelli hill
(image copyright Google Earth)

* Further to the north in the bay of Atheras, a core sample taken about 100m metres south of the current beach confirms that the sea historically ingressed at least to this point, and there is no evidence of a shallow bedrock base at this location.

Tectonic vs. Sedimentary Infill:
An important factor which has emerged from the geological research in Kefalonia is the distinction between a sedimentary infill versus a tectonic dislocation of a valley such as Thinia, as a result of major earthquakes along its fault line.

In a sedimentary infill, the sidewalls and the former seabed of the valley remain unchanged while rockslides tumble down from above to infill and cover it. These rockslides range in size from huge segments of the mountain which can slide down almost intact, through to massive boulders and lumps of debris, all the way down to compacted dust particles.

By contrast, during tectonic deformation whether due to co-seismic thrusting, catastrophic gravity-driven landsliding or a combination of the two, as well as all the sedimentary effects described above, the mountain sidewalls themselves are moved closer together by tectonic forces and the former sediments contained within the valley (including potentially the former marine channel seabed itself) are compressed, folded, transected by thrust faults and uplifted.

In the case of the Thinia Valley some of the compression is linked to an extensional headwall further east. This deformation mechanism is common and typical of unstable slopes where a linked extensional-compressional system develops. Through analysis of the cores and their integration with the geophysical techniques, we are testing whether the part that affects the Thinia Valley may be

consistent with a 'toe-thrust complex', an effect that can be very substantial because of the leverage effect of the sidewall movement.

Since the Thinia isthmus lies close to the impact zone between the African and the Eurasian continental plates and since its eastern valley wall consists of very steeply west-dipping limestones lying tectonically on relatively soft Miocene ‘marl’, a tectonic disruption of the valley is a distinct possibility.

If that is what has happened in Kefalonia, then the task of determining whether the Thinia valley was previously penetrated by the sea is made more complex. With a sedimentary infill, a series of drillholes along the isthmus can be used to extract cores from sea level that can then be tested and dated for marine deposits close to present sea-level. However, with a tectonic infill, this type of investigation is more challenging. Tests for marine materials at sea level are more complex if a former marine channel sediment has now been compressed, squeezed into folds, transected by thrusts and elevated. Consequently, reliance on the position and slope of the present valley sidewalls is no longer practical if they have themselves been shifted by tectonic forces and translational landslides.

Marine deposits have already been discovered at some locations along the Thinia isthmus, and at present the aerial tests, the land-based observations and the results of the core sampling to date support the tectonic infill proposal. If a tectonic infill can be demonstrated then this will also indicate that the former coastline was not a long and narrow marine channel, but may have been a significantly wider and more naturally shaped marine seaway that resembled the existing bays to the north and south.

Summary:
The Thinia valley formation is a demanding geological challenge and the project research team has been fortunate to secure sponsorship for its investigation from the geoscientific company Fugro. The key to understanding this valley is to penetrate below the surface, since surface-based observations are inadequate as a basis for understanding its formation. Over the last few years an extensive range of technology has been used to penetrate the surface of the Thinia isthmus with the aim of finding out what lies below.

The results of the work to date have been published in various professional journals and are also available at the Research pages of the project website, www.odysseus-unbound.org. Although all the evidence collected to date is consistent with the proposal and none of it so far refutes it, at the time of writing further data is required to determine whether or not Strabo’s description of the Thinia valley some 2000 years ago was correct.

Next Steps:
The proposed next step in the research is to conduct marine-based shallow coring at the northern end of the Gulf of Argostoli in order to establish a date profile for the infill of a former marine channel and further investigate the nature of its sedimentary infill. This will provide a baseline from which it should be possible to describe how and when this valley has evolved and been infilled. Discussions are taking place with the appropriate Greek authorities and it is hoped that permission will be given for this marine survey to take place in 2012.

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