What happened to Helike?

by **Roland Pease**

There is little to see today of Helike, just a few walls and artefacts scraped clean by archaeologists. The great Greek city, famed across the classical world, sunk into the coastal mud of the Gulf of Corinth in 373 BC during a terrible earthquake. Writers still recalled its fate hundreds of years later. "The sea advanced together with the earthquake, and the wave dragged down Helike with all its people," reported the traveller Pausanius in the 2nd century AD, adding eerily that "the ruins of Helike are still visible, but not so plainly now as they were once."

Had there been travellers about two million years earlier, the journey north from the temples of Helike to those at Delphi would have been quick and along a simple path. At that time, there was no Gulf of Corinth to separate them. That only started to open up in the crust as tectonic forces pulled the Peloponnese peninsular away from the Greek mainland.

The widening Gulf

Today the Gulf is 100km east to west, from Corinth to Patras, and over 20km north to south. More impressive is its 3.5km maximum depth, a crevice opened up by thousands of tremors over the millennia. Much of that depth is filled by sediments washed down from the surrounding hills.

It is into those sediments that members of the International Ocean Discovery Program (IODP) have drilled – to recover a history of the local environment and of the seismic jolts that sculpted this southern Greek landscape.

"The Corinth rift zone is opening up and pulling apart at some of the highest rates on Earth," says Professor Lisa McNeill of the University of Southampton and co-Chief Scientist of the expedition. "A magnitude six or larger earthquake occurs on average every 10 years in the area,

The four mile long Corinth Canal through Greece connects the Gulf of Corinth with the Saronic Gulf in the Aegean Sea.

On board the *Fugro Synergy*: the Corinth Rift has some of the highest levels of earthquake activity in Europe.
R. Gawthorpe, ECORD/IODP

and today events can impact the populous coastal and tourist communities, including Patras, as well as the large city of Athens."

Helike perished in one such event. More recently, in 1981, three strong jolts hit the eastern end of the Gulf in quick succession over a period of eight days, the first killing 22, and destroying 8,000 buildings.

This is the kind of detail that could help locals protect themselves against the next earthquake, and would have prepared the inhabitants of Helike centuries ago.

History of tremors

The recent seismic history of the region is well told by written accounts and geophysical studies and recordings. The numerous fault lines, where future events will happen, are quite well known. With GPS measurements experts can tell how fast the Pelopennese peninsula is creeping southwards, creating the tension to fuel the next shudder. But to understand the past seismic and geological history, it is into those submarine sediments the team must dig.

Lisa McNeill co-led an international team that drilled into the Gulf's bed in three locations, chosen for the detail they would reveal. The layers of sediments contain geochemical markers, fossil plankton and magnetic properties that reveal their age, as well as pollen, laid down over time. Shaking from earthquakes under or near the basin will have caused landslides and driven sediments into the Gulf along with eroded mountain sediments carried by rivers, as happened at Helike.

"We can use the ages of the sediments to work out how fast the tectonic processes are occurring," Professor McNeill explained.

When tectonic plates move, this creates fractures in the earth's surface that shift over time. This is interesting not simply for the earthquake hazard it poses, but also because of how oceans start to form. Like the Atlantic 90 million years ago. Or in East Africa's Rift Valley and the Gulf of Corinth right now.

Finding answers at the bottom of the sea

Compared with many expeditions to wild parts of the world undertaken by the IODP, the sheltered waters of the Gulf of Corinth may seem like paradise. But they come with their own difficulties.

The waterway is landlocked at the eastern end, apart from a spectacular, deep shipping canal dug through the Isthmus of Corinth at the end of the 19th century. And at the west end, Patras was connected to the Greek mainland 15 years ago by an earthquake-resistant road bridge, which is too low for the *JOIDES Resolution*, the IODP's main drilling ship, to pass under with its tall drilling derrick.

But the team was also able to use commercial research vessels, calling in this instance on the *Fugro Synergy*, a ship mostly used in oil exploration, but well suited to the task. The schedule onboard was punishing – no time even to visit the nearby resorts which were visible from the deck. But in the two months before Christmas 2017, the crew had hauled up 1.6km of sediment core, spanning millions of years of geological history.

Once the team split open the cores, quickly apparent were the major fluctuations in climate conditions over the age of the Gulf of Corinth: the sedimentary record spans several ice ages, during which, Professor McNeill says that erosion increased up to sevenfold because there were fewer plants onland. The evidence also shows that the Gulf was cut off from the Mediterranean during the cold spells as a result of the lower sea level: fresher water organisms took the place of marine ones during these periods.

Preparing for the future

The hard work on reconstructing the tectonics story has only just started. It will matter, says Professor McNeill, because the results will allow the team to reassess which earthquake faults pose the greatest hazard to local populations. "The slip rates we measure, and fault lengths, can be used to estimate maximum likely earthquake magnitudes and the likely level of shaking."