ENVIRONMENT UPDATE

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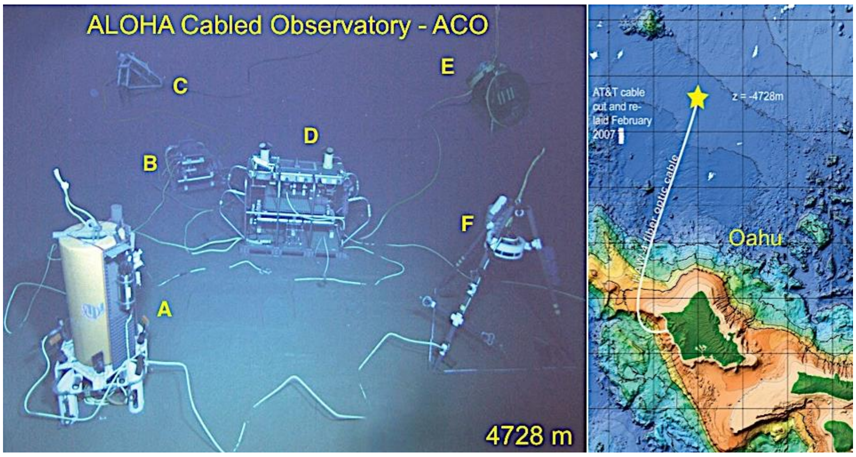
Ten years ago, the retired Hawaii-4 cable was generously made available to become the power and communications backbone of the ALOHA Cabled Observatory, which today continues to provide a wealth of information about the deep ocean. A recent underwater eruption at the *Pacific Ring of Fire* off Tonga, serves as a reminder of the potential hazards associated with active seamounts. The economic and social value of subsea telecommunications and power cables is highlighted in a recent report from the University of Huddersfield. Finally, a new study reveals potential effects of seabed mining on animal communities, which has relevance for seabed recovery from cable burial and repairs.

NEW IN BRIEF: ALOHA ocean observatory – industry/academia collaboration

February 2017, marked the 10th anniversary of linking a section of the retired AT&T HAW-4 fibre-optic cable with a "proof of concept" oceanographic instrument module at Station ALOHA, located 100km north of the Hawaiian island of Oahu **(Fig. 1).** This collaboration between the University of Hawaii and AT&T produced the kernel of what is now the world's deepest operating monitoring site, namely the ALOHA Cabled Observatory (ACO) residing at 4728m water depth [1,2]. ACO builds on a detailed time-series of ship-borne observations at Station ALOHA that began in 1988 and has become the longest physical, biological and chemical dataset for the abyssal ocean (here taken as depths >4000m).

The collaboration was not without difficulty. In particular, there were initial concerns regarding the transfer of ownership of the HAW-4 cable from AT&T to the university. The cable company requested indemnification against legal liabilities and responsibilities. However, that issue was resolved and the university became the new owner.

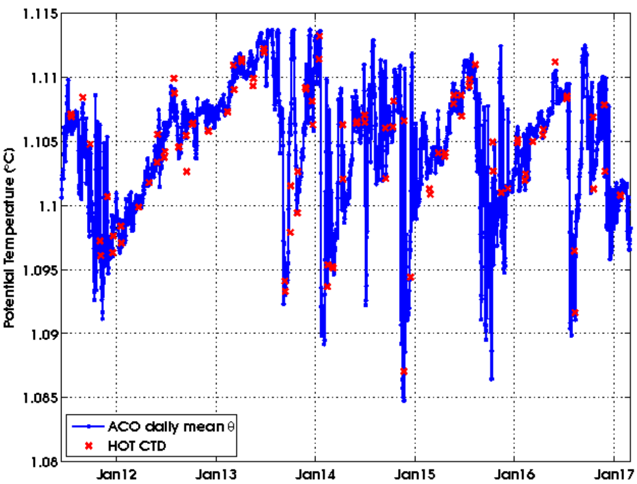
▼ Fig 1. The present ACO as photographed by the remotely operated vehicle, Jason, with images of instruments C and E superimposed on the photograph. Instruments are: A = Secondary instrument node with sensors to measure water temperature, salinity, pressure and oxygen; B = junction box; C = cable termination; D = main instrument node or "observatory" with ocean current and water sensors; E = base of an array of temperature sensors and F = camera and lights. Source: Howe et al., [1] and the University of Hawaii at Manoa.



So what has been achieved? In essence, the ACO provides a window into the abyssal zone, which makes up >70% of the global ocean. The abyss is the main environmental setting for subsea cables. It is also a zone of heightened interest due to deep-sea mining and environmental protection of areas beyond national jurisdiction [3]. The abyss is also one of the least known environments on Earth. In that context, data from the ACO, together with other time–series observations from Station ALOHA, are invaluable indicators of how the deep ocean functions.

Certainly, deep waters do not run still **(Fig. 2).** ACO data reveal a dynamic deep ocean with frequent oscillations of temperature associated with currents of up to 10cm/s (0.2 knots). Some of these cold episodes reflect incursions of water that have escaped from nearby ocean basins. Furthermore, ACO images show the abyssal seabed is far from a biological desert. Six weeks of video monitoring recorded ~110 organisms per week containing 15 identifiable species. There are also the engineering achievements that have allowed the observatory to operate in water temperatures of around 1°C and at pressures of 466 atmospheres.

▼ ***Fig 2. A six-day record of oscillations in bottom ocean temperature characterised by rapid cooling and a slow warming. Source: Howe et al. [1] and related ALOHA newsletter***

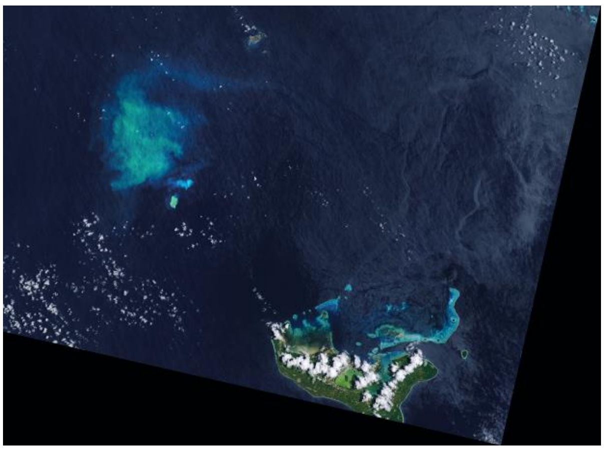


Undersea Eruptions

A recent satellite overflight of the Tonga-Kermadec Ridge, revealed why this oceanic ridge is part of the Pacific *Ring of Fire.* Blue-green discoloration of the ocean confirmed the presence of a volcanic eruption that was underway 33km northwest of Tongatapu – Tonga's main island [4] **(Fig. 3).**

Fortunately, trans-oceanic cables are sited well away from the eruption, but it poses a risk to shipping. Ejected pumice - a highly porous rock that floats to the ocean surface - can clog water intakes of passing vessels. An eruption to the south of Tonga in 2012 created a pumice raft covering over 400km^2. There is also the risk from direct effects of explosions and a lowered ocean buoyancy caused by volcanic gases, which reach a level where seawater cannot support a ship. One or both of those factors resulted in the loss of the Japanese research vessel, *Kaiyo Maru No 5*, which sank in 1953 with the deaths of 31 crew while surveying an eruption of the underwater volcano, *Myojin-sho.*

▼ ***Fig 3. The blue-green patch (top left) is attributed to ash and other material ejected by an underwater volcano or seamount. Previous satellite passes suggest the eruption began on 23 January, 2017 and was still underway when the above image was taken on 27 January 2017. The green, partly clouded island is Tongatapu. Source: Earth Observatory, NASA.***



Subsea cables and the UK economy

It is well recognised that subsea tele-communications cables have tremendous societal and economic importance. Subsea power cables have also become prominent as nations seek to generate renewable energy from ocean winds, tides and waves as well as distributing power from energy-rich nations to energy-hungry markets. Up to now, authoritative estimates of the value of subsea cable infrastructure and services have been lacking. Accordingly, the European Subsea Cables Association (ESCA), together with the UK Crown Estate, commissioned the University of Huddersfield to provide an analysis of the economic and social values of UK cables [5].

In the case of telecommunications cables, their value to the international internet economy was £62.8 billion *per annum* (pa), which was calculated as follows:

- In 2015, the UK internet economy = £180 billion pa
- 36% of UK internet traffic was international = £64.8 billion pa
- 97% of this international traffic is via subsea cables = £62.8 billion pa

For UK subsea power cables the value was £2.8 billion, which was derived as follows:

- UK energy economy = £28 billion pa in 2010
- Offshore wind expected to contribute ~5% = £1.4 billion pa
- Electricity imports are expected to contribute 5% = £1.4 billion pa

Together, the value of UK telecommunications and power cables is equivalent to over 3% of the UK Gross Domestic Product. This may be a modest underestimate because of, for example, marked growth in offshore wind energy production after 2010 [6]. However, this does not detract from the report, which clearly demonstrates the economic magnitude of cables.

In addition of monetary values, the analysis assesses the benefits of the UK cable industry to various stakeholders that range from business to the public. The report also highlights a range of potential benefits of projected growth in the subsea cables sector. However, some concern is expressed regarding uncertainties associated with the UK’s departure from the European Union.

The report, entitled *An Economic and Social Evaluation of the UK Subsea Cables Industry*, is available on the ESCA website [5], and is also proposed for formal publication at a later date.

Seabed recovery from deep-sea mining

Publications on the response and recovery of benthic animals to the deep-ocean mining of polymetallic nodules are not readily accessible. However, that accessibility is improved by a new synthesis of 11 studies world-wide that examines changes in the diversity and density of benthic communities to small scale test mining and scientific disturbance experiments [7].

The synthesis indicates;

- Severe negative changes in faunal abundance and diversity of most animals directly after mining operations.
- Time series made over periods of up to 26 years at 7 Pacific sites, identified some recovery of the diversity and abundance of small seabed animals and mobile large animals such as fish. While recovery was often within one year, few

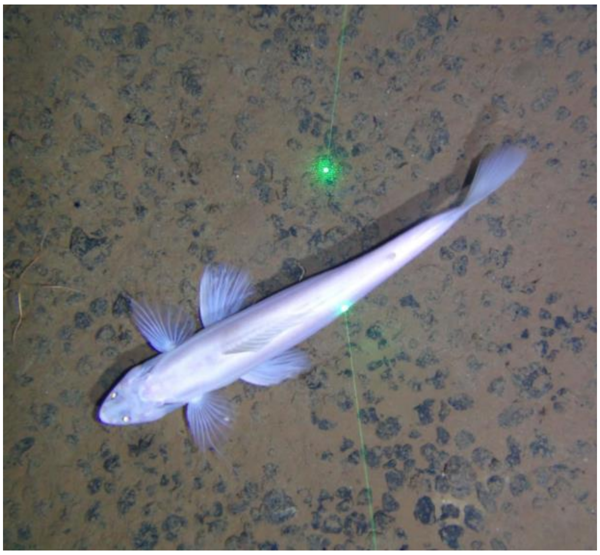
animal groups returned to baseline numbers inside of two decades.

- The mining of polymetallic nodules will probably have a long-term effect on benthic communities.

The good news is that deep-ocean benthic communities recover but the rates of recovery vary with animal groups. However, any application of these results to subsea cables should be kept in context. Deep-sea mining is a (i) prolonged activity that (ii) extends over large areas of seabed and (iii) strongly disrupts the seabed via the proposed dredging techniques. In contrast, deployment of a cable is a brief activity that is confined to the seabed surface over a limited area. In that light, cable laying will cause minimal disturbance to the seabed that presumably will lead to a more complete recovery of the resident fauna compared to that associated with mining disturbance. In addition, effects of cable repairs will also be minimal as faults within Areas Beyond National Jurisdiction currently number just 4 per annum.

The immediacy of research into potential effects of mining on the deep ocean environment as well as other seabed users, is highlighted by increasing commercial interest in marine mineral deposits. In January 2017, the Government of Poland applied to the International Seabed Authority to explore for polymetallic sulphides in 100 exploration blocks (each 10 x 10km) on the Mid-Atlantic Ridge [8].

▼ Fig 4. Polymetallic nodules on a brown muddy seabed of the Clarion-Clipperton region, which is a prime site for deep-sea mining. The fish is Bathysaurus mollis, which was photographed passing close to a brittle star. Source: Image is accredited to Diva Amon and Craig Smith, University of Hawaii at Mānoa.



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ACKNOWLEDGEMENTS

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