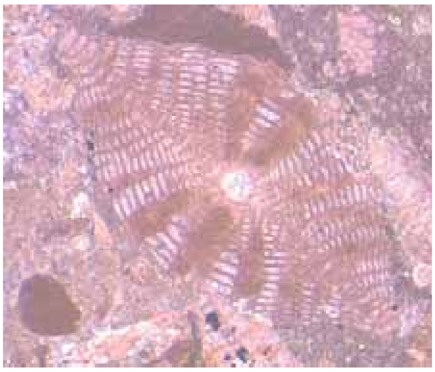
Ian Wilkinson, Stewart Molyneux, James Riding, Paul Shepherd, Michael Stephenson and Mark Woods describe how fossils can help us study global problems such as climate change, environmental deterioration, geological hazards and dwindling energy resources.

Problem-solving fossils

BGS palaeontologists have contributed to projects on every continent and worked with fossils of all ages from the Cambrian to the Holocene. Fossils are used as tools for dating, correlating and determining the environment of deposition of their host rocks, and in modelling climatic, environmental and sea-level change. Applications include mapping, hydrocarbons investigations, civil engineering projects and environmental modelling.

Collaboration with scientists in institutes around the world forms an important part of the work carried out by BGS palaeontologists. An example is the study of Carboniferous, Permian and Triassic pollen and spores of the Alborz Mountains, Iran. Colleagues have mapped the geology of the area in detail and are involved in multidisciplinary analyses of the structural geology, sequence stratigraphy and biostratigraphy of these complex mountains. Stratigraphical gaps and palaeogeographical variations picked out by fossil pollen and spores have helped to reveal the tectonic history and continental calving of the Iranian Block from the southern Tethys margin during the early history of the Tethys Ocean.

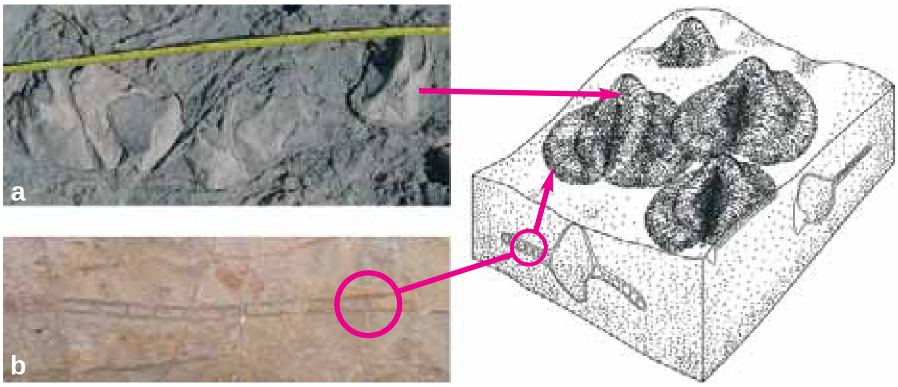
Biostratigraphy, the method by which rock successions are divided into zones and subzones based on the characteristic fossils they contain, is one of the most powerful and cost-effective tools available to understand stratigraphical and facies relationships. An appreciation of these relationships in the siliceous sedimentary Haima Supergroup (Cambrian to Silurian) of Oman, is crucial for efficient exploration and exploitation of gas reserves. Each of a series of marine flooding events is associated with a unique assemblage of marine organic-walled microfossils, including acritarchs (probably cysts of planktonic algae) and chitinozoa (of uncertain affinity, but possibly egg cases). Intervening strata are characterised by low diversity and usually sparse assemblages with spores of primitive land plants, suggesting near-shore marine to non-marine conditions. This indicates that the hydrocarbons-bearing reservoir rocks were associated with advancing coasts and the hydrocarbons seals were formed by marine flooding events.



Thin section of limestone from Papua New Guinea with a specimen of the foraminifer Lepidocyclina (Nephrolepidina) howchini. *This species is confined to the mid-Miocene in northern Australia and Papua New Guinea where it thrived in warm, fully marine waters, at depths of less than about 12m.*

High precision biostratigraphy is founded on detailed taxonomic work. An example of this is a project on Mesozoic dinoflagellate cysts (organic walled microplankton) in Australia. Recent work has shown that it is possible to subdivide the zonation formulated in the 1970s, to give the fine biostratigraphical resolution needed to solve oil and gas reservoir problems. The new subzones have not been formally published because the dinoflagellate cysts upon which they are based, were all undescribed. Collaboration between the BGS and Geoscience Australia has resulted in a resolution of this problem, and the new biozonation will be published in the near future.

Microfossils, such as foraminifera (single celled protista), can also be used biostratigraphically and palaeoenvironmentally. Foraminifera were found to be useful when attempting to determine the rate of subsidence of the sea floor off northern Papua New Guinea. Biostratigraphically useful sea-floor dwelling species were encountered, including shallow water



Reconstructed life position of Wallowaconcha *(based on a figure by Yancey & Stanley, 1999) with (a) valve fragments and (b) large, wing-like extensions strengthened by internal partitions. The wings probably functioned in a similar fashion to snow-shoes, by distributing the weight of the heavy valves and maintaining their orientation.*

Lepidocyclina (*Nephrolepidina*) *howchini*, which dominated a sample from about 850 metres below sea level.

In the United Arab Emirates (UAE) project, enigmatic fossils were discovered in Late Triassic (Norian) strata. At outcrop these fossils are usually seen as ladder-like patterns, but occasionally valve-like forms also occur. These fossils were identified as the giant bivalve *Wallowaconcha*, which hitherto had only been described from Late Triassic strata in North America. This giant bivalve, up to 90 centimetres across, is characterised by large, wing-like extensions of its valve margins, strengthened by internal partitions that, in cross-section, give rise to the ladder-like appearance. The discovery in the UAE indicates that it was more widespread than previously supposed.

Fossils have contributed to a project to determine the origin of gravels found on the side of Kohala Volcano, Hawaii. Although the gravels were only about eight metres above sea level, radiocarbon dating gave an age of 120 000 years old. As Hawaii has been sinking at a known rate, the gravel must have been 400 metres above sea level at that time. Despite this high altitude, the gravel is crowded with marine organisms including fragments of gastropods, bivalves, bryozoans, corals and benthonic foraminifera. One of the keys to the origin of the gravel is that the larger fossils have been pummelled to sub-centimetre scale fragments and the small, robust foraminifera were abraded by highly turbulent water. This and the geological setting indicates that the gravel must have formed as the result of a megatsunami.

Although fossils are often thought of as being millions of years old, faunas and floras only a few decades or centuries old may be examined as part of environmental studies. An example of this is the recent analysis carried out on a large (70 km long) Alpine lake in Armenia. Holocene and modern ostracods (small crustaceans) from Lake Sevan have been studied to determine how they have responded to environmental change during the last 2000 years, and the effects of anthropogenic pressures on the lake. The decline in oxygen, the drop in water level and the change in the annual temperature regime have contributed to the local extinction of some species; in fact it is very difficult to find living ostracods at all.

Vulcanisphaera cirrita, *an acritarch characteristic of Lower Ordovician assemblages in Oman and elsewhere around the margin of the ancient supercontinent of Gondwana. The specimen is approximately 48µm across.*

The BGS's palaeontological collections are of fundamental importance to the day-to-day work of the organisation. They provide an invaluable reference source for users with diverse interests, and many are type, figured or cited specimens. A dedicated staff curate the collections which comprise:

- approximately a quarter of a million macropalaeontological specimens of museum quality;
- two million macrofossils stored within the stratigraphical collections; and
- over 200 000 micropalaeontological slides.

Although predominantly of British origin, many thousand specimens and slides have been collected from projects around the world. Information relating to the collections, is recorded in registers and *PalaeoSaurus*. This is the BGS palaeontological database and can hold a complex identification history, a complete bibliography, and full taxonomic details, as well as locality information, registration and collection details.

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