



*A section of faultrock in the Cretaceous Toki Granite in borehole MIU-2 from the Mizunami Underground Laboratory site near Toki City, in Honshu, Japan.*

The BGS has provided geological data and interpretations concerning the safe storage and disposal of radioactive waste for the past 40 years and was one of the main geological assessment contractors for UK Nirex Ltd during their Sellafield and Dounreay investigations in the 1990s.

Since 1997, and the shut down of the investigations at Sellafield in Cumbria, the BGS has not been inactive in the nuclear waste disposal field. We have continued to undertake generic work for Nirex and have assumed responsibility for the borehole cores and other geoscientific information emanating from the Sellafield studies in particular, which were transferred to Keyworth in 2001. At Dounreay, in Caithness, the United Kingdom Atomic Energy Authority (UKAEA) has embarked on a lengthy programme to restore the site as far as possible back to a brownfield status

restoring as much of the site as possible. As part of this process, UKAEA needs to have a good understanding of the geology and hydrogeology of the site and surrounding area, primarily so that the distribution and potential migration pathways of contamination known to be present can be better defined. We have been involved in this programme in a number of ways.

Mapping of the Quaternary geology and of parts of the Devonian succession of northern Scotland was already scheduled as part of our field survey programme. UKAEA co-funded work on the Dounreay area to ensure that the resurvey was undertaken early in the programme with a focus on their needs, so that the data were available to be used in the hydrogeological assessment of the site. The field mapping around Dounreay was completed in 2003. As a separate part of these field investigations, UKAEA

# Radwaste disposal

## Working towards a long-term solution

by Richard Shaw and Clive Auton

suitable for unrestricted commercial use, although the distinctive ‘golf ball’ shell of the fast-breeder reactor may remain, because it is a listed building.

Internationally, we have been involved in several projects including natural analogue studies, particularly of natural cement minerals in Jordan, uranium–copper mineralisation in Devon, and an EC/industry funded palaeohydrogeology study. We have also undertaken studies for national radioactive waste disposal companies in other European countries. Some of this work is described elsewhere in this issue. We have also worked for several organisations involved in the Japanese radioactive waste disposal programme.

### Dounreay

Following the shut down of all the research reactors at Dounreay, UKAEA has started a programme of site remediation with the eventual aim of

commissioned a more detailed study to characterise the Quaternary geology of the Dounreay catchment for their wider study of water balance in the area. This work included the excavation of a number of pits to enable detailed information on the hydrogeological characteristics of the glacial and postglacial sediments in this catchment to be collected.

The new mapping highlighted the uncertainty that still remains about the correlation of the Devonian bedrock below the site. It has been examined in cores obtained from two Nirex boreholes drilled in 1991, more recent cores taken in a number of boreholes drilled on and around the site by UKAEA and the rocks exposed at surface in the area. A pilot project, commissioned by UKAEA, to work towards a better understanding of the sequence of Devonian rocks in the area has recently been completed. This study has been using microfossils extracted



*Spore microfossil from the Devonian rocks at Dounreay.*

from fine-grained rock samples taken from both core and outcrops to help to resolve the differences in interpretation of the geology between the recent geological mapping and the new borehole evidence. Further work is planned, to complete this correlation and to extend the study to ‘fingerprinting’ other rock types in the area, principally sandstones and thin limestones, again using fossils but in conjunction with whole rock geochemical analysis and petrographical studies.

Another recent study has been a review of the evidence of changes in relative sea level and the position of the shore line since the deglaciation of northern Scotland, 13 000 to 14 000 years ago, until the present. More work, including sampling of shoreline sediments that can be related to these changes and dating of samples to better constrain rates of sea-level change have just been completed.

Other work is planned for Dounreay including studies of fractures in bedrock and their infills to help to gain an understanding of past and present fluid flow through the near-surface rocks.

### Japan

Japan is one of the few countries that are still going ahead with the construction of new nuclear power stations. In the past few years, it has started a long programme that is intended to lead to the eventual development of a facility for the disposal of nuclear waste. For many years the nuclear industry in Japan has collaborated in international projects working on generic radioactive waste disposal problems. For instance, it has been involved in various work packages in underground research laboratories, including Äspö (Sweden), Mol (Belgium) and Grimsel (Switzerland) and in a number of natural analogue studies. We have collaborated in many of these projects and have good relationships with a number of the companies that are involved in the Japanese programme.

One of the early tasks undertaken by the government organisation responsible for radioactive waste management in Japan was to undertake a review of the state of the art in the field of radioactive waste management in the rest of the world. This large task was commissioned from a number of organisations with an international reputation in the field



*Dounreay fast-breeder reactor on the north coast of Scotland.*

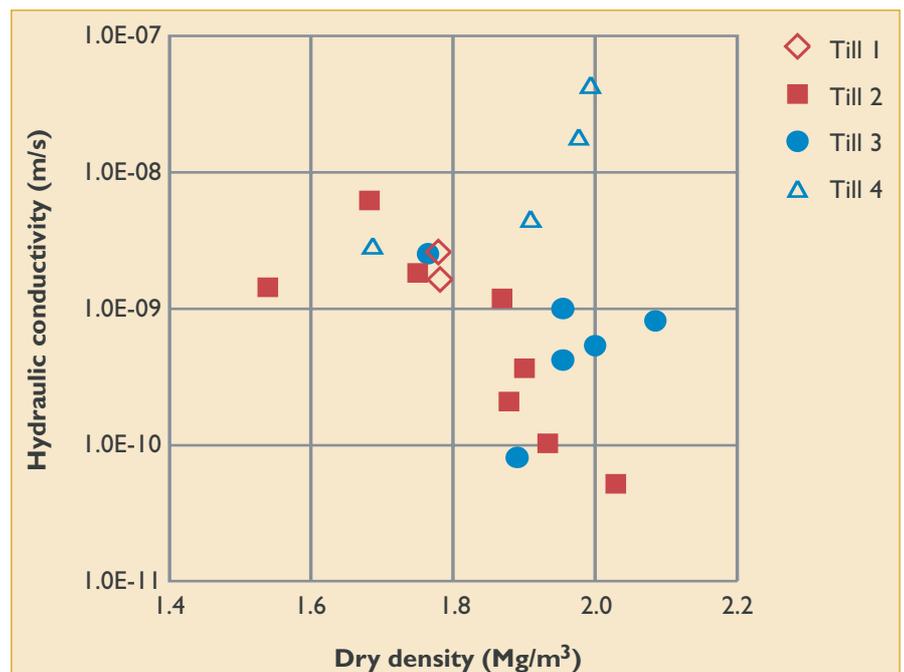
including the BGS. Our main contribution was to report on the application of geophysical methods used by the national programmes in Finland, Sweden, Belgium and the UK for site selection and site characterisation, the potential for the use of these methods and of new techniques in the Japanese programme. The report of this work is now published in Japanese.

We continue to undertake work for the Japanese radioactive waste programme, having recently contributed to the international peer review of some of the proposed investigation methodologies and by providing specialist geoscience services to several organisations in Japan. ■

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*Hydraulic conductivity of glacial tills from the Reay Burn catchment, Caithness.*