Benjamin Levich (1917–1987)

BENJAMIN Levich, the most highly placed 'refusnik' scientist to be allowed to emigrate from the Soviet Union, died on 19 January. Levich was known internationally for his work in physicochemical hydrodynamics, which he was the first to establish as a separate scientific discipline. His research activities included gas-phase collision reactions, the quantum mechanics of electron transfer and the development of a rotating-disk electrode as a tool for research.

By 1972, he had attained the post of Professor of Chemical Mechanics at Moscow State University (the chair was created especially for him), and was a corresponding member of the Soviet Academy of Sciences. But in that same year, after consultations with his wife Tanya and his sons Alexander and Evgenii, he decided to apply for emigration to Israel.

Immediately his teaching post was abolished, he was demoted to the rank of a 'scientific worker', and shortly afterwards his younger son Evgenii was illegally transported to a military camp in the Soviet Arctic. Levich was informed that he would never be allowed to emigrate, because of his knowledge of state secrets.

A campaign for the Levich family was organized by Dr Brian Spalding of Imperial College London. This campaign attracted considerable attention, particularly when it became known that western publications including *Nature*, distributed in photostat form in the Soviet Union, had all references to Levich deleted from them. But the campaign was suddenly halted with the news that Levich had reached a gentleman's agreement with the emigration authorities: if the public outcry ceased, Alexander and Evgenii would be allowed to emigrate at once together with their wives, and Benjamin and Tanya would follow a year later. But when the time came for the senior members of the Levich family to emigrate, the Soviet authorities denied any knowledge of such an agreement.

In 1977, a conference on physicochemical hydrodynamics was held in Oxford, in honour of Levich's 60th birthday. Such an honour is virtually a matter of routine for scientists of his rank in the Soviet Union, but, in his circumstances, no Soviet honours could be expected. The conference was so successful scientifically that it was decided to launch a regular series of Levich conferences. The second was held in Washington, DC in 1978, and within three weeks, Benjamin and Tanya Levich arrived in the west. They settled first in Israel, where Levich had a chair reserved for him at Tel Aviv University, and in 1979, he accepted the Albert Einstein chair of physics at New York City College, commuting regularly between the United States and Israel. Shortly after he took up this post, however, his wife Tanya had to have massive heart surgery, from which she never fully recovered. She died in 1984.

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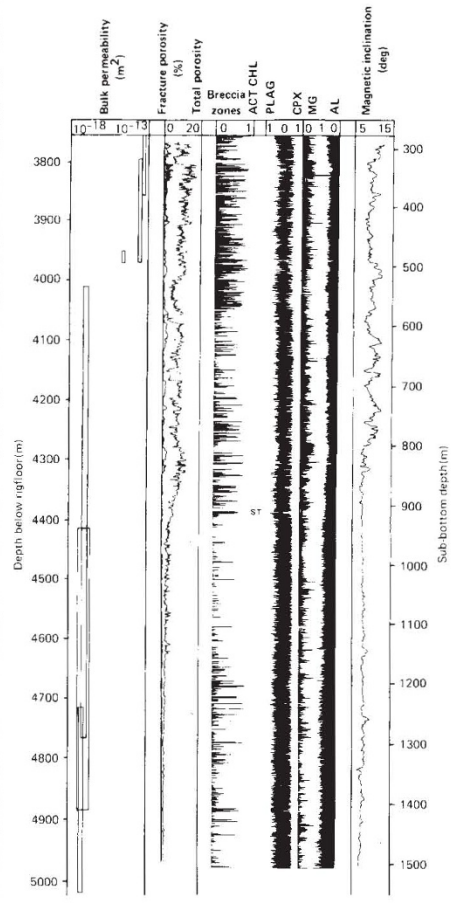
permeable to such circulation, largely because the original porosity of the basalts has been sealed by deposited alteration products. The upper 100–200 m of basalts remain permeable, and in fact ocean bottom water actually flows down the hole and into this section of basement. This flow was observed when the hole was first drilled by DSDP Leg 69, but the rate of flow has decayed to less than 1 per cent of its original value.

Similar downhole flow of ocean bottom water has been observed in other holes drilled through the sedimentary layer into young oceanic crust. This flow does not affect the conductive temperature profile in the deeper layers of hole 504B. The equilibrium crustal temperature at the total depth of 1,562.3 m is estimated to be 165 °C.

Logs

Given the poor recovery of core from hole 504B, our geophysical logs were especially important in providing a continuous image of the formation (see figure). Several logs, particularly those of sonic velocities and electrical resistivity, clearly distinguish individual extrusive and intrusive basaltic units that are of the order of 10–20 m thick. We also looked at these units with sophisticated neutron-activation tools that resolve relative abundances of several key elements and allow the construction of continuous logs of geochemistry and mineralogy. These 'chemical logs' show that the secondary alteration products are confined to fractures along contacts between relatively unaltered units of fairly homogeneous geochemistry. This confirms that contacts between units were originally porous and permeable, but have been sealed by deposition of hydrothermal alteration products. The logs show that the present porosity of the sealed crust is quite low, ranging from 10–15 per cent in the upper 100–200 m of pillow lavas to less than 1 per cent in the deepest sheeted dykes.

A magnetometer log revealed a significant difference in the magnetic inclinations of the pillow lava section and the sheeted dykes. The overlying pillow lavas are inclined about 15 per cent, whereas the dykes below are inclined less, about 8 per cent. This seems to require a tectonic explanation, and suggests that the contact between pillow lavas and sheeted dykes in hole 504B is a relic of early listric faulting within the axial rift. Such faulting might have provided the highly permeable conduits for circulating hydrothermal fluids that produced an 18-m-thick mineralized stockwork sampled at the base of the pillow lavas.



Geophysical experiments in hole 504B. Left to right: bulk permeability measured by the packer experiment; fracture and total porosities determined from electrical resistivities; hypothetical (normative) mineralogies; and relative magnesium oxide and aluminium oxide contents. Normative mineralogies were determined by recalculating the content of Si, Al, Fe, Mg and Ca into the normative components actinolite (ACT), chlorite (CHL), plagioclase (PLAG), clinopyroxene (CPX), olivine and smectite, assuming typical local compositions for the normative minerals. Normative plot units indicate the fraction (1 is 100 normative weight per cent) of the rock formed by each normative component. Relative contents of magnesium oxide (MG) and aluminium oxide (AL) are shown as counts, where 1 signifies the maximum observed. Average amount of magnesium oxide is 7 weight per cent and that of aluminium oxide is 22 weight per cent. ST denotes the 18-m-thick stockwork-like unit.

Our detailed vertical seismic profile of the hole showed that there are two major seismic reflectors about 100 and 450 m deeper than the hole now extends. One of these reflectors is probably the transition between the sheeted dykes and the ultramafic gabbros, the next major layer of the oceanic crust. This transition may be within reach of the next visit to hole 504B. □