is a federal agency under the control, not of local legislative bodies, but of the US Congress 500 miles away.

Until very recently, TVA has been held in such affection by most residents of the Tennessee Valley—particularly those with long memories—that the remoteness of the control over the agency has been no problem. But recent sharp increases in TVA's electricity rates in response to escalating coal prices have caused some alienation and frustration because there's no local body to which complaints can be addressed. The frustration was voiced on several occasions during last year's Senate hearings on TVA, the most provocative comment being the reference to colonialism, but few suggestions for improving the situation were voiced.

Nevertheless, to most of the people in the region, TVA remains an instrument for economic progress. Certainly, few would deny that it has more than lived up to Roosevelt's hopes that it would reclaim the Tennessee Valley's land and people. □

## US SPACE

# Biological business boom

*Sandy Grimwade reports from Washington on the progress of the Viking 1 experiments on Mars*

AFTER more than five weeks of practically faultless operation the Viking 1 Mars lander continues to send a wealth of geological, meteorological, biological, chemical and visual information back to Earth. The only instrument which has failed to function correctly is a set of miniature seismometers which remains locked in the safe landing position, despite efforts to free it. The other teams of scientists have, however, been kept busy by the sheer volume of information being supplied to them.

Some of the most puzzling and to the general public most fascinating data have come from the three biology experiments and the related molecular analysis of the Martian soil. Although control and duplicate experiments—the *sine qua non* of all biological investigation—have not yet been done, speculation is rife as to the meaning of the results so far. The scientists involved are understandably cautious about delivering a yes–no answer to the question of life on Mars, when only a small portion of their programme is complete. The results so far are certainly not what would be expected if Earth-type organisms were present, nor are they explicable in terms of "simple" non-biological chemistry.

In the labelled release (LR) experiment, a mixture of $^{14}C$-labelled nutrients in a small amount of water was added to a soil sample and incubated at about 15 °C, which is 35–135 °C warmer than the Martian surface temperature. The totally unexpected result showed a massive and rapid release of radioactivity into the gas phase—presumably as carbon monoxide or dioxide. The radioactive counts released reached 4,500 in 10 hours, levelling off after 48 hours at about 8,500. A second dose of radioactive nutrients caused an initial burst followed by a drop in the released radioactivity, after which the graph almost flattened out for the remaining four days of the experiment.

That "almost" is the tantalising part, because careful statistical analysis revealed a possible trend of very slow accelerating release of radioactivity. Unfortunately, the exigencies of operating one's laboratory by remote control across 200 million miles required the experiment to be stopped for performance of a control test with heat-sterilised soil. A later repetition of the experiment is planned with an incubation time of weeks or months rather than days. The results certainly do not look like anything one would expect from an Earth sample in the same situation. A chemical explanation involving oxidation of the labelled nutrients is at present the most popular explanation for the initial burst of activity.

The possibility that the Martian soil contains active oxidising agents was strengthened by the result from the gas exchange (GE) experiment. In this experiment the soil sample is either humidified or wetted with a concentrated "chicken soup" of amino acids, salts, vitamins and other nutrients, and the atmosphere is periodically monitored for changes in the concentration of gases by gas chromatography. The initial humidifying of the soil sample produced a remarkable release of oxygen which levelled off after several hours and remained stable for days. Wetting of the soil caused a rapid drop in the atmospheric $CO_2$, probably due to the formation of bicarbonate in the alkaline solution, and a slower drop in the oxygen, which is speculated to be due to oxidation of ascorbic acid which is present in the nutrients. At present, $CO_2$ is slowly being released into the atmosphere and the experiment is intended to continue for some time to see if any further changes occur. As the instrument is capable of detecting very small changes in hydrogen, methane, nitrogen and other gases, a wide range of possible biological activities could be detected.

The results of the GE and LR experiments are open to several more or less imaginative interpretations, and attempts are at present being made to duplicate the results in several Earth laboratories using simple catalysts and oxidising agents. The third experiment, the pyrolytic release experiment (PR), although perhaps the most complex technologically, is also the least equivocal when it comes to interpretation of the results. It is designed to detect the fixation of labelled carbon monoxide and dioxide in organic compounds. A sample of soil is incubated in a Martian atmosphere with added water vapour and irradiated with a simulated sunlight xenon lamp. After five days the sample is heated to 625 °C to pyrolyse organic compounds which are trapped as vapours, and to drive off unreacted CO and $CO_2$. This unreacted gas is passed through a radioactivity detector and forms the first "non-biological" peak. The organic vapour trap is then heated to 700 °C to release and oxidise

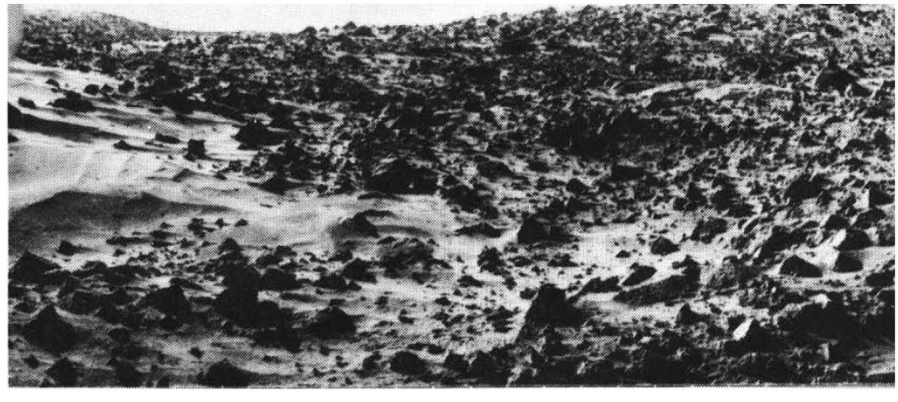

Photo: NASA

*Martian dune field*

the remaining organic compounds which form the second, "biological" peak.

With a sterile sample a peak ratio of about 500 to 1 would be expected. The result from the Martian soil was about 75 to 1 due to the high "biological" peak. This is several times more active than non-sterilised soils from the dry valleys of Antarctica. The result from the control experiment with heat-sterilised soil is crucial in this instance, a high peak ratio indicating the possibility that biological rather than chemical processes capable of fixing atmospheric carbon monoxide or dioxide in the presence of light are taking place in the soil. If life exists on Mars, this is what might be expected in the soil surface which is strongly illuminated and bathed in an atmosphere of about 95% carbon dioxide. The biologists would be even more encouraged if organic compounds were detected in the Martian soil.

Unfortunately, the initial run of the organic chemistry analysis was less than satisfactory due to the temperamental soil sampling boom which apparently failed to deliver a full load of soil to the gas chromatograph-mass spectrometer. No organic compounds were detected. A full soil load has now been obtained and a further analysis is being carried out. If organic compounds are not detected this would be a blow, though not a fatal one, to the concept of life on Mars, and would render interpretation of the three biology experiments more difficult. □

## USSR SPACE

# Forward with the programme

*Vera Rich reports on the latest Soviet space missions*

"Soviet science considers the creation of orbital space stations with interchangeable crews as the main highway of mankind into space. They can form 'cosmodromes in space', launch pads for flights to other planets. Large-scale scientific laboratories will arise for the investigation of space technology and biology, medicine and geophysics, astronomy and astrophysics."

So said Mr Brezhnev in a recent statement. The idea was by no means new; it is a fundamental tenet of all Tsiolkovskii's work that such a station would and must precede manned exploration of the moon and planets. There are, indeed, some indications that Soviet space planners have at times been prepared to consider the alternative of manned exploration direct from earth—the argument that a lunokhod-carrying automatic spacecraft could carry out its survey work at "half the cost" of a manned mission, for example, suggests that the latter possibility had at least reached the costing stage. Now, the flight of the unmanned Luna 24 has repeated the task of Luna 16 by obtaining and returning with a sample of moon-rock, though from a depth of two metres and from *Mare crisium*, from which no samples had yet been obtained. Presumably present space plans still do not envisage cosmonauts venturing beyond earth orbit.

Whatever the overall timetable of the Soviet Union's space plan, though, many of the experiments now being conducted by the 7-week-old Salyut 5 mission suggest that the concept of a permanently manned space station is still well to the fore. These latter experiments fall into three main groups: geophysical and astrophysical observations, technological experiments and biological experiments. Of the technological experiments, some are directly concerned with processes and techniques which would be required in the construction of a space station—notably the study of the behaviour of gases in liquids in space and, of some importance, a soldering experiment. Unlike the welding experiments of an earlier mission, the soldering, which uses a highly exothermal chemical reaction to produce the necessary heat, is aimed less at testing the cosmonaut's dexterity than at investigating the process itself. The welded metal specimens are to be returned to earth for further investigation of their structure.

The emphasis has clearly shifted to the properties of materials treated under conditions of weightlessness. Other experiments include the growing of crystals (also to be returned to earth), and the cooling of molten metals—bismuth, lead, tin and cadmium—to determine surface tension. These experiments will, of course, provide data of considerable theoretical significance: crystals grown under weightlessness, for example, should be free of convection-induced defects, and should, it is hoped, provide valuable comparative data for crystallographers and geologists. It is significant, however, that all these experiments are described in the official announcements as "technological", suggesting that their practical importance should not be minimised.

The medical problems of prolonged spaceflight are also receiving considerable attention. Apart from such obvious parameters as muscle tone, cardiovascular and respiratory performance, and loss of body weight—measured on the special "massometer"—the medical programme includes special monitoring of the cosmonauts in a "vertical" position (however that is to be interpreted), tests on reaction time in performing complex operations and manual control (real or simulated) of the spacecraft (the simulated control presumably relates to possible emergencies), and even possible variations in taste.

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Photo: Novosti

*Before blast-off for Salyut 5*

Press comment on the medical programme suggests a growing concern over the psychological effects of prolonged spaceflight. These would arise from a lack of external stimuli, the restriction of living space and general monotony—an aspect of spaceflight which will assume ever greater importance in future missions when the length of flight and the crew size increases. Aboard Salyut 5 are such simple prophylactics as recorded music (from folk to classical) and a varying make-up of the ration-packs.

Commenting on the radiation safety system used aboard the Salyut craft, Ludvig Palmbakh of the USSR Institute of General Genetics stated that the protective measures used are "well adapted" for work near Earth, since, if solar radiation rises to danger level, the crew can be quickly evacuated and brought back. For deep-space missions, however, "more active" means of protection would probably be required, possibly involving the deflection of high-energy particles by electromagnetic fields. The design of such systems entails considerable technical difficulty, so the fullest possible information is required both on the nature of the radiation and the actual hazard involved. The cytological and genetic experiments, using drosophila and hawksbeard, carried by Salyut 5, should provide further data on these hazards. □