Various Descriptions of the Viking Pyrolytic Release Experiment

1) From Klein, H., Lederberg, J. et. al. 'The Viking Mission Search For Life On Mars' 1976 (in *anticipation* of the touchdown of the *Viking I* Lander on July 4th, 1976; the actual landing took place on July 20th).

The pyrolytic release (or carbon assimilation) experiment is designed to measure either photosynthetic or dark fixation of CO_2 or CO into organic compounds[10,11]. Both of these gases are known to be present in the atmosphere of Mars, and the experiment is designed to simulate, as closely as conditions permit, the actual Martian environment. The experiment hardware includes a xenon arc lamp with a spectral range and distribution quite similar to the solar spectrum, and with an intensity of about 20% of the maximum Martian solar irradiation at the surface. The light source is provided with a filter to remove ultraviolet radiation below 340 nm to prevent the non-biological fixation of carbon monoxide into organic compounds, as has been reported by Hubbard *et al.*[12,13]. For this experiment, 20 μCi of a mixture of $^{14}CO_2$ and ^{14}CO (in a ratio of approximately 95: 5) is injected into the headspace (containing Mars atmosphere) above a 0.25-cm^3 surface sample that has been sealed off in one of the three incubation chambers provided. Incubation proceeds for the next five days in the light.

While the incubation is proceeding, a long background count is taken. Following this period, the original incubation atmosphere is automatically vented, and the sample is pyrolysed by heating to 625 ºC. During this stage of the experiment sequence, any residual initial radioactive CO or CO_2 will be driven out of the sample, through a column, the organic vapour trap (OVT), and into a ^{14}C detector, while organic fragments will be adsorbed on the OVT. After counting at this point in the sequence, the radioactive gases in the detector are automatically vented, and the detector is then heated to remove adsorbed gases. Following this step, and several additional helium purges of the OVT and the detector, the organic matter that had been trapped on the OVT is now eluted by heating it to 650 °C for 3 min. During this heating, any trapped organics are released from the column and are simultaneously oxidised to CO_2 by copper oxide present in the packing of the OVT. The effluent from this procedure is purged into the detector and counted. A radioactive peak at this time would constitute presumptive evidence for biological activity, to be followed by a control experiment using heat-sterilised soil.

In addition to the sequence just described, the experiment can be modified by the introduction of water vapour into the incubation atmosphere by commands from Earth. Another commandable option in this experiment is to turn off the lamp to conduct a dark incubation.

2) From NSSDC Master Catalog Display: Experiment, 'Biology (GEX/LR/PR)'.

The PR, or carbon assimilation, instrument sought to detect the photosynthetic or chemical fixation of CO_2 or CO containing C-14. The samples were incubated for several days in the presence of the radioactive gas mixture, some samples with simulated sunlight and some without. Next, each sample was heated to 120 C to remove unreacted CO_2 and CO. The soil was pyrolized at 650 C and any organic products were collected in an organic vapor trap (OVT). Finally, the trap was heated to combust the organic material to CO_2 and any evolved radioactive gas was measured.

3) From Mazur, P. et. al. 'Biological Implications of the Viking Mission to Mars' *Space Science Reviews* **22** (1978) 3-34.

To date, the results of the PR experiment have not been simulated abiologically, and possible abiological explanations are speculative. It seems clear that picomole quantities

of organic compounds were synthesized in several of the PR experiments. The specific observations were that after the Martian samples (no H_2O added) were irradiated at >320 nm (0.5% < 320) in the presence of $^{14}CO_2$ and ^{14}CO, and then pyrolyzed at 625 ^oC, significant quantities of ^{14}C-containing material were retained on the organic vapor trap (OVT) at 120 ^oC. Heating of the OVT to 650 ^oC released this material and oxidized it to $^{14}CO_2$ where it was detected as the '2nd' peak.

Comments:

Pyrolization Temperature: It will be noticed that whilst the account of Klein, H., Lederberg, J. et. al. (1) agrees with that of Mazur, P. et. al. (3) on the sample's pyrolization temperature of 625 ^oC NASA's NSSDC source (2) does not giving instead a temperature of 650 ^oC. Although (1) & (3) do speak of heating organic matter to 650 ^oC this is done to *remove it from the OVT* and to convert it to CO_2 for measurement; the NSSDC source, however, indicates that as a result of this heating organic matter *accumulates* in on the OVT before the latter is then finally heated to measure the evolved CO_2.

Heating of the OVT: Unlike Mazur and colleagues Klein et. al give no indication that the OVT should ever have been at a temperature of 120 ^oC and neither does NASA's NSSDC source (2). Accounts (1) and (3), however, do agree on the temperature (650 ^oC) to which the OVT was to be/was heated (recall Klein, Lederberg et. al. were describing the experiments in *anticipation* of their use on Mars not afterward). The reason given for this heating – namely, to release and oxidize organic materials from the OVT to CO_2 for measurement – also agrees. In this respect, the NSSDC source is also in agreement, although it gives no temperature for the heating of the OVT.