The technical dimension

BEFORE the Second World War, there were just two windows on the world beyond the atmosphere of the Earth: the radiation from external stars and galaxies that happens to fall within the part of the electromagnetic spectrum visible to the human eye, and cosmic rays. In practice, the study of cosmic rays was chiefly of interest as a route to particle physics without particle accelerators. The detailed study of the ionosphere was a way of gathering information by proxy about the behaviour of the Sun, and was not especially successful.

The transformation of astronomy since 1945 consists of the extension of astronomical observations to what is essentially the whole of the electromagnetic spectrum. The development of radioastronomy in the 1940s and 1950s appears to have been inspired directly by the successful wartime use of radar based on microwaves, with wavelength of the order of 1 cm or so.

Similarly, the development of infrared astronomy, beginning in the 1960s, owes much to the development of sensors for military purposes, while Herbert Friedman, one of the pioneers of X-ray astronomy in the United States, relied on captured V2 rockets to launch his first X-ray experiments.

But the refinement of these techniques in the hands of astronomers has yielded accuracy and sensitivity of a kind to which the military would not have aspired.

Much the same characterizes the exploration of the objects of the Solar System in the past few decades. Here on the Earth, radar was used in the 1960s to provide a picture of the solid ground beneath the Antarctic ice cap, just as it has been used by the US Magellan spacecraft to provide a detailed (and astonishing) picture of the topography of the surface of Venus (see Fig. 1).

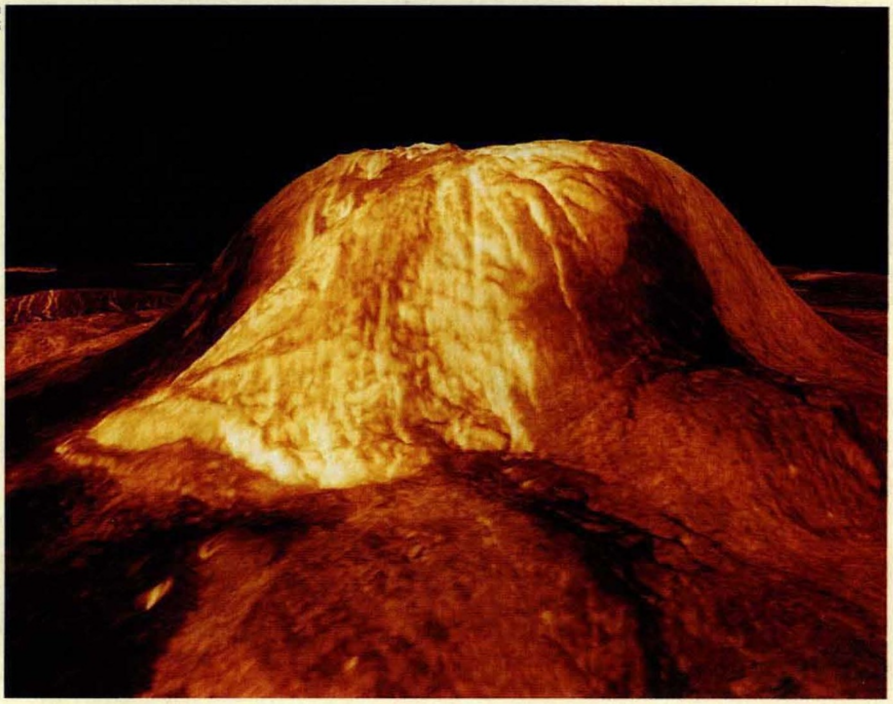

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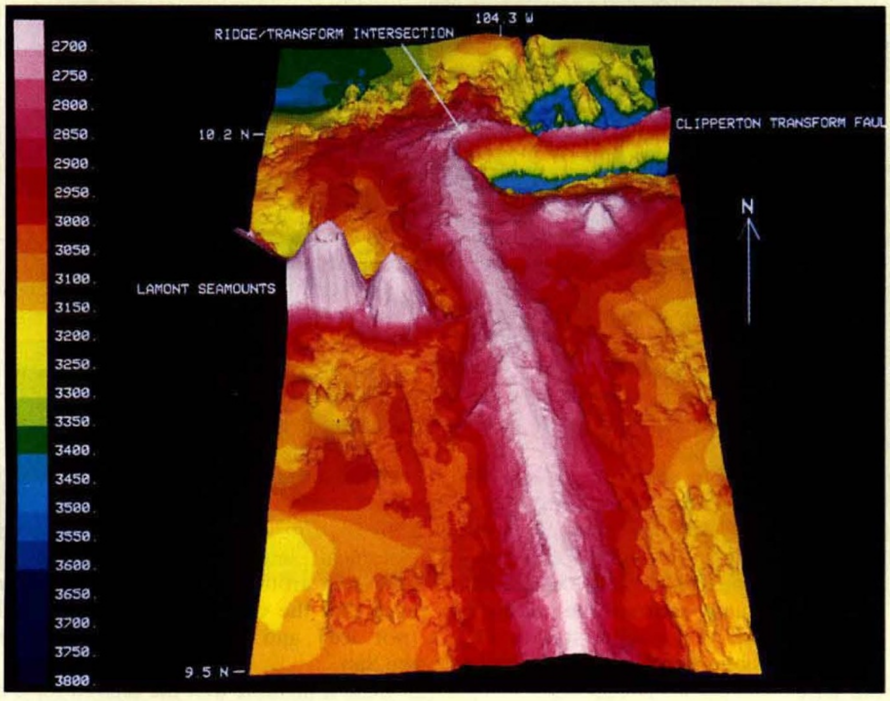
FIG. 1 Simulated view of the surface of Venus, constructed from radar elevation data obtained by the Magellan spacecraft. The main feature is Gula Mons, a 3-km-high volcano.

Military and diplomatic interests also provided, in the 1960s, a powerful impetus for the development of sensitive seismographs for the detection of nuclear explosions, which has powerfully reinforced the traditional use in geophysics of seismic signals from distant earthquakes as a means of inferring something about the internal structure of the Earth. The more recent spectacular results of the use of sonar for the exploration of the deep-ocean floor is a similar case (see Fig. 2).

To refer to these connections is not to diminish astronomy or geophysics, but rather to raise a question about the future. If, with the ending of the Cold War, military development budgets are everywhere reduced, will basic science have to rely on its own resources, themselves ultimately provided by governments, for the continued development of techniques? Or is it realistic to hope that the partnership with industry that governments everywhere are urging on the research community will sustain the development of new techniques?

Perhaps the most remarkable development has been the widespread use of the light detectors known as charge-coupled devices (CCDs) — solid-state photon detectors whose sensitivity, at least in the visible part of the spectrum, approximates to the ideal, and the response of which (unlike that of photographic emulsions) is linear with intensity. CCDs have become in 15 years a standard source of images of the sky, and one pre-digitized for easy computation. □



Plotting software courtesy of R. Tyce, NECOR/Sea Beam facility

FIG. 2 Shaded-relief image of the East Pacific Rise and its intersection with the Clipperton transform fault. High-resolution 'swath'-mapping using sonar systems such as Sea Beam has provided a detailed view of mid-ocean-ridge structure and magmatism.