LETTERS TO THE EDITORS

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Ferromagnetism of Meteorites

THE aim of this communication is to describe some preliminary results on the magnetic behaviour of some stony meteorites, namely, Allais, Cold Bokkeveld and Orgueil. Paramagnetic resonance absorption has been used in order to be able to investigate ferromagnetic resonance and eventually paramagnetic particles or free radicals at the same time. These were not unexpected on account of the relatively high content of organic material of the selected meteorites¹. The apparatus used was a Varian X-band microwave spectrometer. In no case was a sharp electron spin resonance observed, which seems to indicate that paramagnetic species are not present in significant concentrations. Instead a broad line occurred, which is presumed to arise from ferromagnetic resonance. The location of the maxima and the line-widths between the inflexion points are shown in Table 1.

Table 1

Name	Max. H_0 (oersteds)	Line widths (oersteds)
Allais	3,100	2,320
Cold Bokkeveld	3,100	2,460
Orgueil	3,100	2,250

The spectroscopic splitting factor (g), deduced assuming a random distribution for the crystallites, amounts to 2.19. This is not in disagreement with the corresponding values observed for nickel magnetite² and ferrites³. If the results of the elemental chemical analyses⁴ are interpreted in terms of mineral compounds, it may be inferred that these substances are present.

It is to be noted that we have now at our disposal an objective method for studying the evolution of ferromagnetic content through the group of stony meteorites. Further research on this problem is now in progress.

We are greatly indebted to Father J. Junkes, director of the Spectroscopic Laboratory of the Vatican Observatory, for the loan of specimens of meteorites. Our thanks are also due to Varian Associates for putting a spectrometer at our disposal.

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¹ Müller, G., *Geochim. Cosmochim. Acta*, **4**, 1 (1953).

² Kittel, C., *Phys. Rev.*, **76**, 743 (1949).

³ Healy, jun., D. W., and Johnson, R. A., *Phys. Rev.*, **104**, 634 (1956).

⁴ Urey, H. C., and Craig, H., *Geochim. Cosmochim. Acta*, **4**, 36 (1953).

Removal of Gases in High Vacuum Systems by Metal Abrasion

CHEMICAL reaction with metal films (gettering) is a well-known process for the removal of free gas in vacuum devices. However, removal can cease once a thin layer of reaction product has formed.

Thus the layer of oxide which forms on fresh aluminium surfaces at room temperature is protective¹, and so are the layers of oxide that form on the initially reactive metal, titanium². Similar protective layers of compounds other than oxides also occur—see, for example, a recent review³.

In order to overcome such limitation upon capacity for taking up gas, pumps have been designed⁴ in which titanium is evaporated continuously, to provide films having fresh surfaces highly reactive with gas molecules. However, to evaporate titanium fast enough for the pump to take up gas at a useful rate (say, a few litres/ μ sec.), the metal must be raised above its melting point (1,670° C.), as vapour pressure data⁵⁻⁷ show. Unfortunately, at such high temperatures, titanium is so reactive that there are few suitable materials from which to make hearths for holding the molten metal.

As alternative to overlaying the protective reaction products with freshly evaporated titanium, a promising idea is abrasion of the oxide, or similar layer, to expose the fresh titanium beneath. Only a very thin layer of oxide has to be removed, so scratching rather than, say, turning seems appropriate. Some preliminary experiments demonstrating the reaction of gas with a freshly abraded surface of titanium will now be described.

A trough was made from sheet titanium and in it were put a few lumps of some suitable abrasive, such as 'Carborundum' (Carborundum Co., Ltd., Manchester 17), or some pieces of an old metal file. The titanium trough was mounted in a glass bulb to which was attached both an ionization gauge for measuring the pressure of free gas and a porous ceramic appendage through which fresh free gas could be introduced at will from a surrounding jacket that could either be filled with known gases or evacuated. As a start the whole device was evacuated, baked to remove water vapour, and sealed off containing free gas at some pressure less than 10^{-6} mm. mercury. Then gas was admitted through the porous ceramic tube just fast enough to maintain the pressure at, say, 10^{-4} mm. mercury, in spite of the reaction of the gas with the hot tungsten filament and some loss to the walls (clean-up). (With oxygen the loss by reaction with the filament is appreciable—see, for example, ref. 8—but with nitrogen is negligible). When the lumps of abrasive were shaken about in the trough of titanium, or the bits of file dragged back and forth therein by means of an external magnet, the pressure fell rapidly, in less than a minute, to 10^{-6} mm. mercury. By admitting more fresh gas this fall could be demonstrated repeatedly in any particular tube. After many runs using lumps of abrasive so much powdered debris covered the bottom of the trough that gas was not taken up as readily as at the start. But in such a tube the previous best performance was maintained by dragging about the bits of file with a magnet; for in this way loading upon, and mechanical damage to, the titanium was greater.

Since air contains about 1 per cent of argon, it might have been expected that it would be impossible to reduce the pressure again below about 10^{-6} mm. mercury, and that after each successive admission of fresh gas the background pressure of free argon would increase. But this did not happen. It is true that the most rapid fall of pressure upon shaking and scratching occurred for the first hundredfold reduction; but it continued thereafter more slowly,