to the region sensitive to titanium. Although a minor misbehavior appeared in some of the data, it seems incapable of explaining the values obtained; data in periods not displaying this anomaly gave the same analytical results. Limits are given in Table 1 for groups of elements with masses greater than 61. In addition to the spectra of elements listed in Table 1, those of B, N, P, and Cl have been included in the libraries for the analyses, but have been found to make no contribution to the lunar-sample spectra.

The results presented in Table 1 for the composition of lunar surface material are within the ranges given in the preliminary report for Surveyor V (1). The errors assigned now, however, are considerably smaller.

In general, the data for the two lunar samples examined on the mission agree. A major disagreement is in the values for carbon. In view of the uncertainties uncovered in the analysis for this element in terrestrial rocks by this technique, it cannot be concluded that carbon has been detected in lunar surface material. Its abundance is almost certainly less than 2 atom percent.

The amount of sodium, reported earlier only as an upper limit of 2 percent, has now been set at a value of 0.4 percent. In addition, the presence of titanium in significant amounts has been established. The data on the other minor elements speak primarily to their absence in appreciable amounts.

The values for oxygen in Table 1 are slightly greater than required to oxidize the iron to FeO and all of the other metals to oxides. This slight excess of oxygen, if real, may be in the form of water, carbonates, or higher oxides of iron. If the mean values of the lunar surface analyses of Table 1 are converted to an oxide weight composition, the results in Table 2 are obtained.

The more precise results in Table 1 make even more certain most of the conclusions drawn in the preliminary reports: the chemical composition does not correspond to that of the nonvolatile components of the sun's atmosphere, to that of terrestrial ultrabasic rocks, or to that of the most common chondritic meteorites. The low silicon and high iron and calcium values rule out a granitic composition. The preliminary results indicated a similarity in chemical composition with that of terrestrial basalts and basaltic achondrites. The comparison of the present,

more precise and comprehensive, data with these two classes of rocks is shown in Fig. 1. The three most abundant elements (oxygen, silicon, and aluminum) still agree within our estimated errors. On the other hand, the low value for sodium and high value for titanium appear incompatible with the composition of most terrestrial basalts; the high value for titanium and the relatively low value for iron are at variance with the content of these elements in eucrites and other calcium-rich achondrites. Thus, there appears to be no common material on earth that matches, in all respects, the chemical composition of lunar surface material at Mare Tranquillitatis. This uniqueness suggests detailed geochemical processes somewhat special to the history of this material. Moreover, the present, more complete, analysis of the Surveyor V data gives evidence that mare materials in different parts of the moon differ in at least one minor constituent. The alpha spectrum at the Surveyor VI mare site (Sinus Medii) differed slightly but significantly from Surveyor V spectra in the energy region sensitive to the presence of titanium (2). There is a clear indication that the titanium content at Sinus Medii is less than at the Surveyor V site.

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Rare-Earth Elements and High Pressures

Abstract. *Praseodymium, under very high pressures, shows a magnetic behavior similar to that of cerium at normal pressure.*

One can observe the magnetic behavior of solid solutions of the rare earths in ZrB_{12} under the high pressures exerted by the extreme rigidity of the boron lattice. Of all known dodecaborides, ZrB_{12} has the smallest lattice constant, $a_0 = 7.408$ Å (1). We have been able to substitute several atom percent of most rare-earth elements for Zr in ZrB_{12}. The atomic radius of Zr (1.60 Å) is much smaller than the atomic radii of the rare earths, which range from 1.86 Å for La to 1.72 Å for Lu. Since ZrB_{12} is superconducting at 6°K (2), an indication of the effect of this pressure on the magnetic configuration of the dissolved
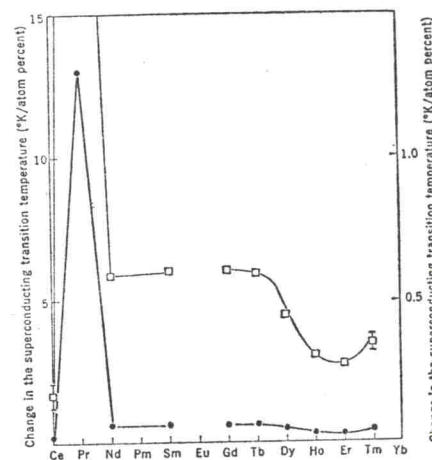

Fig. 1. Depression of the superconducting transition temperature of ZrB_{12} by rare-earth impurities; right scale ($\square$) is an expanded version of the left scale ($\bullet$).
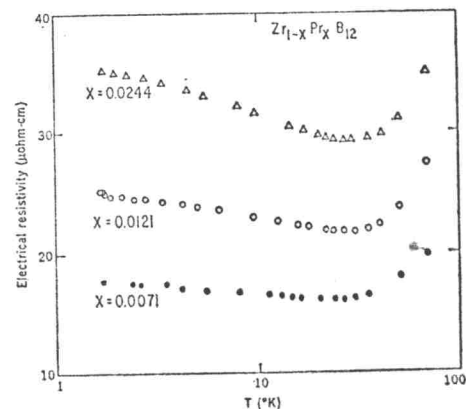

Fig. 2. Electrical resistivity (ρ) of $Zr_{1-x}Pr_xB_{12}$ alloys plotted against the logarithm of the temperature.