THE GEOLOGY OF THE TERRESTRIAL PLANETS

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FOREWORD

With the launch of Mariner 2 to Venus in August 1962, for the first time man reached beyond the confines of Earth to explore the rest of the solar system. The two decades that followed have appropriately been called the Golden Age of Planetary Exploration, for a succession of ever more sophisticated spacecraft has been sent throughout the solar system, visiting every planet as far out as Saturn. One spacecraft, Pioneer 10, has even left the solar system and is at the start of an endless journey through interstellar space.

The advance in our knowledge of the planets as a result of this activity is so enormous that it is difficult now to look back to the time of that first launch and appreciate how primitive our perception of the planets was then. Even the terrestrial planets, those closest to us, were almost unknown. Mercury was known only to have a few smudgy markings, Venus appeared as a featureless disk, and our notions about Mars were colored by a false belief in the presence of canals. Now these bodies are comfortably familiar, and we have a sound basis for hypothesizing how they might have formed and evolved to their present state. For the Moon, a planet-sized body (though actually a satellite), the advances are especially striking. In 1962, the Moon was commonly perceived as a primitive undifferentiated body, a sample of the primordial stuff of the solar system. The origin of its numerous craters—whether by impacts or volcanism—was hotly debated, and estimates of the age of the surface ranged from billions of years to relatively few. There then followed a series of spacecraft missions which culminated in the landing of men on the lunar surface during the Apollo program and the return of samples to Earth for analysis. We discovered that the Moon, like Earth, has experienced a complex geologic history which can be precisely outlined by dating returned samples. The origin of most craters was unequivocally established as impact, and the surface was found to be ancient. In several ways, the geologic history of the Moon is now more securely established than that of Earth.

Concurrent with this vigorous exploration of the solar system was a revolution in the science of geology. Indeed, the two decades following 1962 might also be called the Golden Age of Geology, for it was during this time that the theory of plate tectonics was formulated. Exploration of the sea floor, detailed monitoring of global seismicity, and discovery of reversals in Earth's magnetic field all led to the conclusion that Earth's surface is divided into large rigid plates that move with respect to each other. This perception transformed the discipline of geology by integrating a multitude of seemingly disconnected geologic observations into a single satisfying theory. Furthermore, we are beginning to realize that impacts, which have been so dominant in sculpting the surfaces of other planets, have also had a major role in the evolution of life on Earth.

Thus, the knowledge gained through space exploration is leading to the new science of comparative planetology. Although each planet is unique, all have much in common. While each can be studied independently, a greater understanding is achieved by examining the entire set. This book outlines the geologic history of the terrestrial planets in light of recent exploration and the revolution in geologic thinking. That such a volume could be written at all is a tribute to the engineering virtuosity that has made planetary exploration a reality.

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