THE SELENOGRAPHIC ORIENTATION OF THE APOLLO 12 ROCKS DETERMINED BY NONDESTRUCTIVE GAMMA-RAY SPECTROSCOPY

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ABSTRACT

A number of experiments dealing with erosion rates on the lunar surface, optical properties, magnetic properties, and the irradiation history of the lunar surface require a knowledge of the recent and past orientation of the rock samples returned from the lunar surface. In order to allocate specimens for these experiments, it is highly desirable that this orientation be known before the rock samples are subdivided. We have developed several methods using nondestructive gamma-ray spectroscopy to determine the selenographic orientation of returned lunar samples. The methods are based on the fact that solar flare protons produce several radioisotopes (such as ^{26}Al, ^{22}Na, ^{56}Co, and ^{54}Mn) close to the surface of the lunar rocks facing the sun. The isotope gradient can be detected by scanning the whole rocks with a detector sensitive to gamma-rays. Since the signal to noise ratio is small, careful experimental design and statistical analysis is necessary. The half-lives of these isotopes ranges from a few days to about a million years permitting determination of not only the recent but also the past orientation of the lunar rocks. By using these methods the orientation of several rocks was established. The orientation of rock 12002 was determined with a confidence of about 99%. More detailed studies on thin samples removed from the surfaces of rock 12002 confirmed the orientation deduced from measurements on the

whole rock. The position of rocks 12021 and 12051 have also been determined with a confidence of about 95% and their orientation does not agree with the selenographic orientation determined from lunar pictures by the field geology team.