

Analyzing the Genesis Rock and others

But there were a few subnuclear particles around that did not respond to the strong force, the electron, the mu meson, the neutrino. There were also a number of radioactive decay processes, especially the beta decay of nuclei, that took a long time by particle-physics standards, indicating that a much weaker force than the strong interaction was operating in them. Theorists put all these various phenomena into a bag marked weak interaction and tried to devise a theory that would explain them all as particular cases of the action of a weak force. In doing so they predicted the existence of the W particle. They knew the W would be hard to find because the theory required it to be a very heavy particle, but exactly how heavy the theory didn't say.

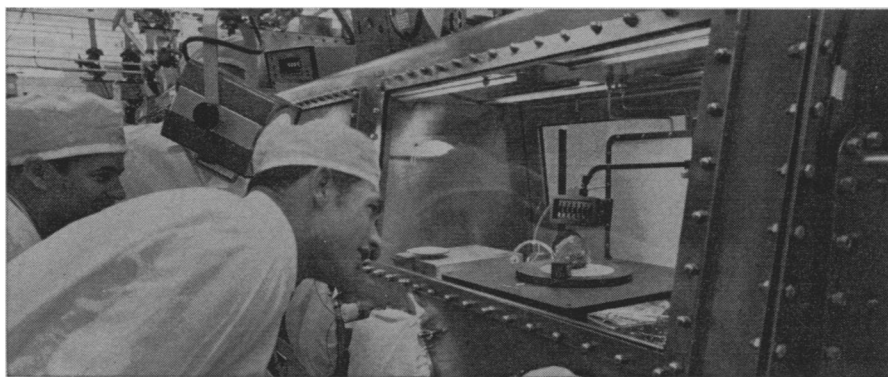
The Utah experiment gives an estimate, a mass of approximately 37 billion electron-volts (GeV). By comparison, a proton's mass is 0.938 GeV, and the heaviest particles heretofore known are no more than a few GeV. Because of certain characteristics of the W particle, says Dr. Keuffel, its existence requires the existence of other particles in the mass range 30 to 40 GeV. This would be a whole new class of particles interacting among themselves, and for high-energy physics, says Dr. Keuffel, "It changes the ball game."

At the high energies where the W particle appears (in the thousands of GeV), says Dr. Keuffel, the ordinary weakly interacting particles behave in a strange semiweak way. One of the consequences of the weakness of the weak interaction is a very low probability that a weak-force particle will interact with other matter. A neutrino can pass through the whole earth, for example, without interacting with anything else on the way.

But at these ultrahigh energies, says Dr. Keuffel, a neutrino should be stopped after about 1,000 feet of rock. Such high-energy neutrinos should also be able to decay into mu mesons, something that low-energy neutrinos do not, and a number of other strange things should happen. "It opens up a whole fascinating speculation," he says.

It may also lead to an independent test of the W-particle hypothesis. If all this is true, neutrinos with energies of 1,000 or 2,000 GeV should produce spectacular and visible events as they interact in the rock, and the Utah physicists intend to look for these events.

Dr. Keuffel says that other physicists who have been given advance notice of the finding have reacted with great interest, but also with great caution. Final acceptance will depend on confirmation of the results. This, he says, may be difficult since no other detector is as big as the Utah one. □



NASA

Astronaut Scott examines the "Genesis Rock" in its germ-free chamber.

It has long been an open secret that lunar scientists are less than happy about the policy of sending pilots to the moon to do geology. Thus, last week, it came as a singular honor to the Apollo 15 astronauts, David R. Scott, James B. Irwin and Alfred M. Worden—all Air Force pilots—when they were described repeatedly as "new geologists in the profession."

"The astronauts have apparently the best understanding yet of that site [Hadley/Apennine]," says Dr. Paul Gast, chief of the planetary and earth sciences division at the Manned Spacecraft Center, "and this may remain that way for a long time."

"In all cases so far," said Dr. W. C. Phinney, chief of the geology branch at MSC, "where we have looked at what the rocks are, they match exactly what the astronauts said they were [on the lunar surface]." Scott and Irwin had seen green rocks, white rocks and pink rocks. They had identified some as breccias, some as basalts, and one in particular as an anorthosite.

As bag number 196 with the anorthosite was unwrapped last week in the Lunar Receiving Laboratory, all hopes were realized. The one-half pound white rock—called by some the "Genesis Rock"—was an anorthosite—a crystalline rock of the sort formed at great depths in the earth and therefore likely to represent the original crust of the moon. To prove it means showing the rock is 4.6 billion years old, the best current estimate for the moon's age.

The anorthosite is probably a calcium aluminum silicate and could therefore be a confirmation from the ground of what the Apollo 15 orbital X-ray instrument was recording—that the highlands were richer in aluminum than the maria. From the returns of Apollos 11 and 12, geologists knew that the maria were rich in iron—one thing that makes them appear darker than surrounding areas. The scientists had hypothesized that the highlands could

be rich in aluminum, which would give them their lighter color. If this were true, then the highlands could also be made up of anorthositic material—possibly remnants of the original lunar crust.

But dating the rock may be very difficult. Early this week the white rock was tested: it had the lowest concentrations of radioactive thorium, uranium and potassium of any sample yet returned from the moon. This makes the standard age-dating methods—by comparing concentrations of the products of radioactive-decay chains with concentrations of the elements that start them—largely ineffective.

Geologists are also anxious to see if the rare Apollo 14 material, called KREEP, which has a high content of potassium, rare earths, uranium and phosphorus, shows up in the Apollo 15 samples. How KREEP relates to the material believed to be the lunar crust is another problem. One hypothesis is that during the partial melting of the moon, the crustal materials—such as the anorthosite—would be the first to melt and crystallize. The KREEP would be what is left over after the crust had been formed.

Another important source of information has been the core sample which took several man-hours of drilling to secure from beneath the moon's surface. "This is the best thing we ever did on the moon," remarked Scott of the 8-foot core. An X-ray of one-half the core (the top three sections) revealed 24 distinct layers, each differing in grain size, distribution and thickness. "We are now sure that we have in that core a record of the events at the Hadley site probably over billions of years," says Dr. Phinney.

What that history is may be slow in unraveling. This week scientists debriefed the astronauts. Next week the preliminary examination team at MSC will begin the three-month chemical analyses of the returns.