A TECHNIQUE FOR DETERMINING PLANETARY COMPOSITION UTILIZING GALATIC COSMIC RAY AND SOLAR FLARE INDUCED SECONDARIES I: CHARACTERISTIC NEUTRONS FROM THE LUNAR SURFACE., M.S. Spergel[+], York College of C.U.N.Y., Jamaica, N.Y. 11451, O.W. Lazareth[*] and P.W. Levy[*], Brookhaven National Laboratory, Upton, N.Y., 11973.

Under investigation is the feasibility of determining planetary composition by remote sensing of galatic cosmic ray and solar flare induced secondaries. More particularly, the energy spectra of these secondaries from the lunar surface has been examined. Observational data of the lunar soil from the Apollo program allow one to determine the sensitivity of the energy and intensity of induced secondaries to surface conditions. The expected induced neutron and prompt gamma ray fluxes has been calculated within the lunar surface. The analyses of the sensitivity of the gamma ray flux to surface composition is discussed in the following paper.

Calculations are made for the expected induced neutrons from both galatic cosmic rays and solar flare primaries. Various production mechanisms (1,2,3) for the induced neutrons were considered. A production mechanism with an 'e- folding length' of 155 gm/cm^2 was taken with an evaporation energy spectra for the neutrons (1). Also considered for the galatic induced neutrons was a mechanism with an 'e- folding length' of 165 gm/cm^2 and an energy spectrum which combined evaporation with harder knock-on neutrons (2). The solar flare induced neutrons were taken as produced within the top 15 gm/cm^2 of lunar soil with an evaporation type energy spectrum. The neutron flux is then calculated using a 100 energy group neutron transport (4) code. The calculation utilizes a recently revised neutron cross section library, (5). The calculation was performed assuming isotopic and anisotopic neutron scattering.

Results are displayed in Figures 1 and 2. Figure 1 pointedly indicates that the neutron flux at a given energy varies strongly for differing sources of primaries and neutron production models. The lunar soil considered in both figures is that of Apollo XI (6,7). Figure 2 shows a different result, the energy spectra of the neutrons for the various primary and secondary sources are remarkably similar. The neutron energy spectra reflects the nuclear cross-section spectra of the soil nuclides, particularly the abundant oxygen nucleus.

Soil composition appears to be the dominant factor in influencing induced neutron energy spectra. It should be expected that studies of induced neutrons could lead in turn to determination of soil composition. The neutron albedo, the neutron component measurable from remote devices similarly reflect this behavior, and may be useful in determining planetary soil composition.

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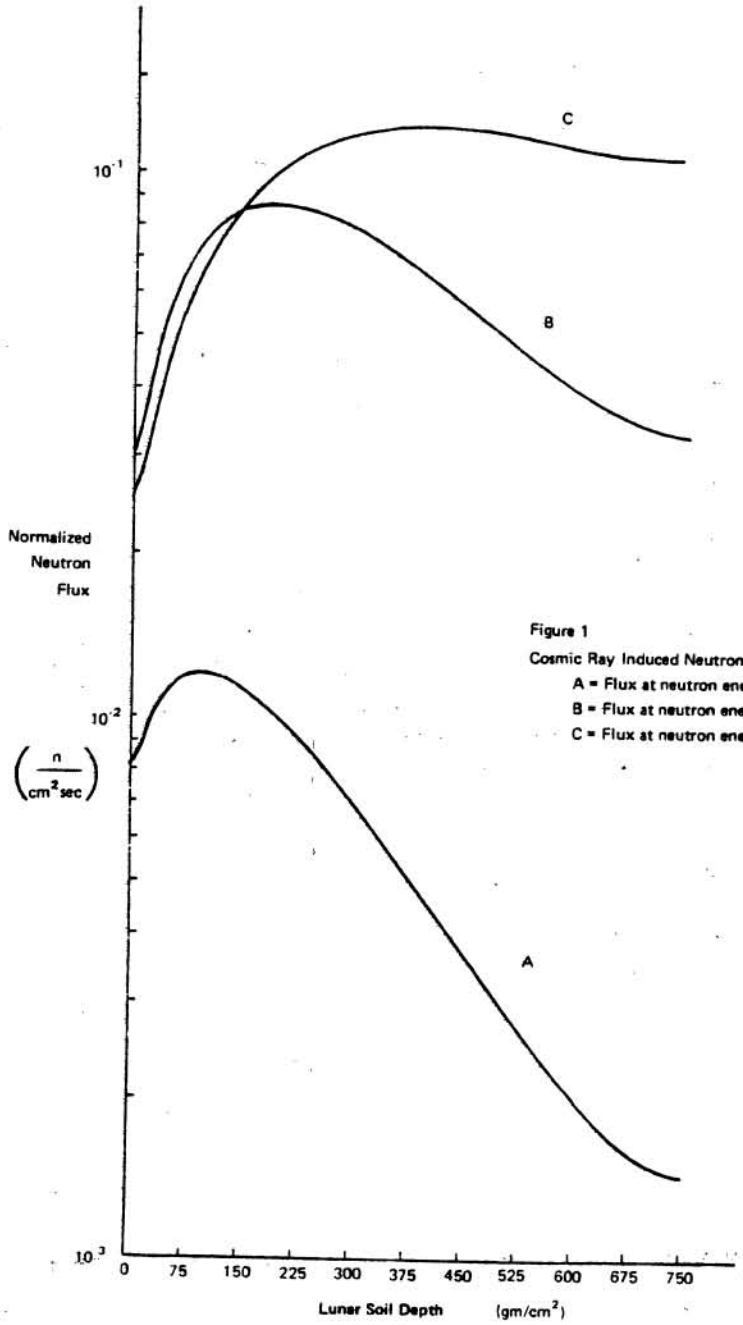

Figure 1
Cosmic Ray Induced Neutron Flux
A = Flux at neutron energy of 5MeV
B = Flux at neutron energy of 0.5 MeV
C = Flux at neutron energy of 0.05 MeV

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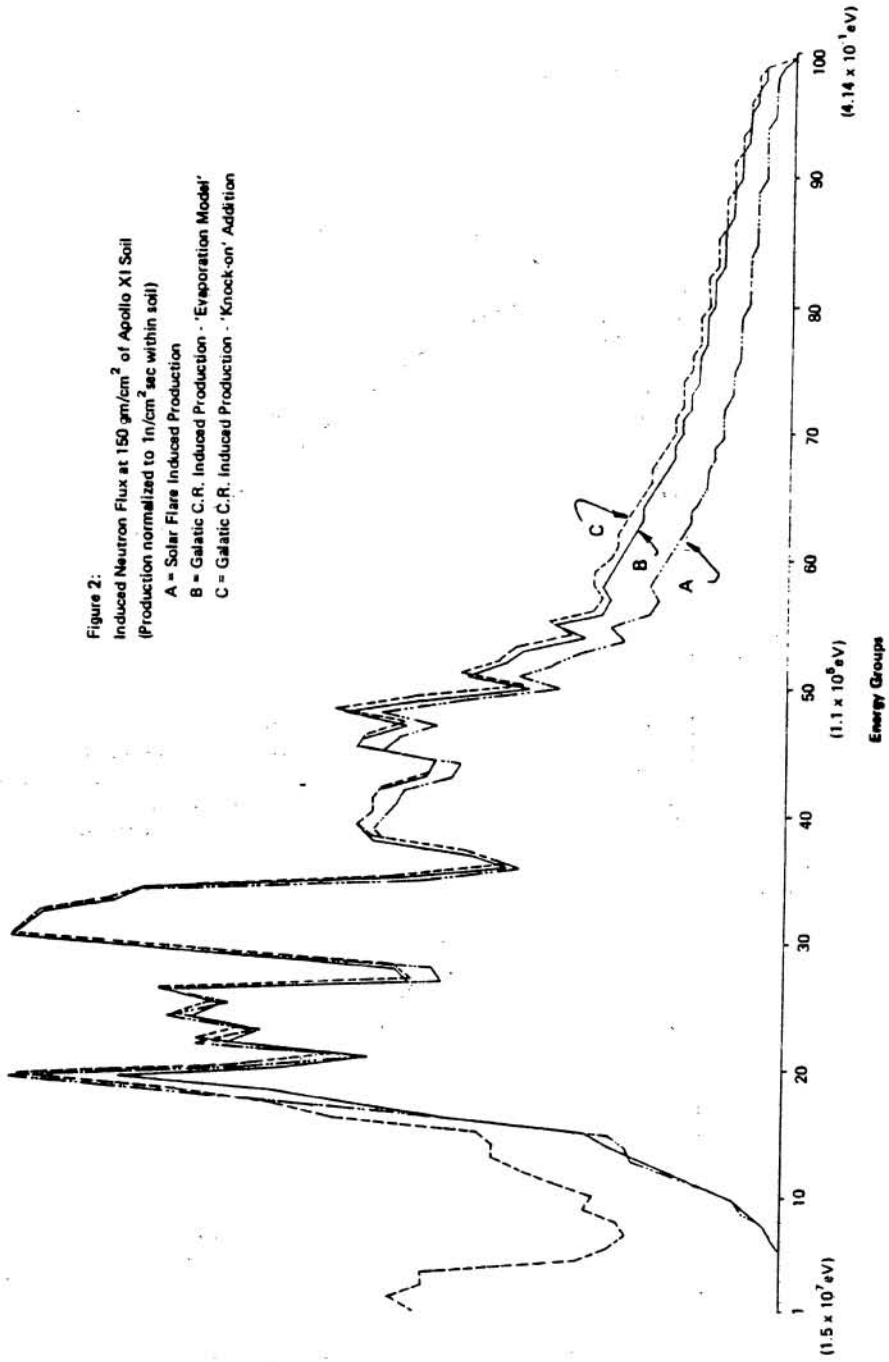

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