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Lunar seismic network sensitivity depending on network geometry

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The Moon's interior was seismically investigated using a four station seismic network in context of the US Apollo missions, which recorded artificial and natural impacts on the surface as well as moonquakes in two different depth ranges: 50-300km and 700-1300km. The Apollo seismic stations were deployed on the lunar near side within a circle of 40 degrees diameter and operated between 1969 and 1977. Most of the recorded shallow and deep moonquake events were located on the lunar near side and only a few known impacts generated seismic waves travelling through the lower most mantle or core of the Moon. Lunar seismic velocity models mostly reach only down to depths of 1000 kilometers, two thirds of the lunar radius. Hence the global distribution of lunar seismicity is itself of interest, illuminating the Moon's questioned interior symmetry, and to enhance the radial velocity model.

We try to derive optimized network geometries from the distribution of the recorded seismicity. Therefor we compared locations and location uncertainties of deep moonquake clusters found with an adaptive grid search method (LOCSMITH, Knapmeyer 2008, GJI 175) to hypocenter determinations of Nakamura (Nakamura 2003, JGR 139) and thereby verified LOCSMITH's approach for lunar deep quakes. Clouds of possible hypocenters found for each cluster, appear in four different shapes. We adopted these as measure for location accuracy. In order to understand why uncertainty volumes assume certain shapes, we started to model crust properties like attenuation along the ray paths and used this to compute theoretical network sensitivities for proposed as well as highly optimized, but also very expensive network designs. The sensitivity of a network depends on its geometry and the sensitivity of the single seismometer, the hypocenter with its specific distance, depth, magnitude and focal mechanism, and the media along the ray paths with its defined velocity, attenuation and scattering properties. We present the geometry dependency of the location shape classification, the achievable spatial, especially depth, resolution of seismic networks as a function of the number of available seismometers.