

Electromagnetic Wave Propagation through Rock Blocks of Pyramid

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We are investigating the inner structure of the great pyramid in Giza, Egypt by using electromagnetic wave propagation[1]. The pyramid is made of rock blocks having typically the size of 1.5m x 1.5m x 1.5m, but their size and shape are irregular. The surface of each rock block is not flat, therefore, there is a gap between rock blocks. Many attempts have been conducted to investigate the inner structure of pyramid by using ground penetrating radar (GPR), but in many cases, we cannot obtain clear images, because of complex EM wave propagation mechanism due to this rock structure.

We used FDTD modeling for observation of EM wave propagation in the rock blocks, but as a simple model, we propose to use a transmission theory to understand the basic behavior of the EM wave propagation[2].



Figure 1. Rock Block Model

Figure 1 shows the simplified 1-Dimensional model of the rock blocks. We set blocks and air gap between blocks. The total length of one rock block and air gap spacing is fixed to 1.5m. We assume 30 blocks, and the total length of the blocks is 45m. We model this 1-D structure as a cascade transmission lines, consisting from 2 different propagation constants and length. Formulation of the wave propagation can be done by using F-matrix of a uniform transmission line. We calculate the transmission coefficient in the frequency domain, and then we transform it to the time domain to observe the time-domain response, since most of the GPR survey observe the time-domain signals.

Figure 2 shows the time-domain signal propagated through the 1-D rock block model. The input impulse contains frequency 1-50MHz. We can find the multiple reflection caused by a larger spacing between rock blocks. We are investigating optimum time-domain signal wave form and frequency range, that can penetrate inside the pyramid.

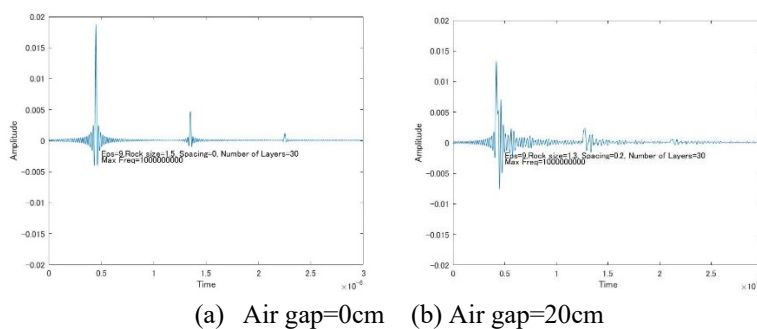


Figure 2. EM wave propagated through the rock block model

1. M.Sato and A. El-Hameed, "Electromagnetic Wave Propagation Inside the Great Pyramid, Egypt," URSI GASS, August 2024.

2. R. Zabihi and R. Vaughan, "Simplifying Through-Forest Propagation Modelling," *IEEE Open Journal of Antennas and Propagation*, **1**, January 2020, pp. 104-112, doi: 10.1109/OJAP.2020.2969127.