REMOTE DETECTABILITY OF OXYGEN THROUGH GEOLOGICAL TIME AROUND FGKM STARS.

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Introduction: Observations of terrestrial exoplanet atmospheres will occur for planets at different stages of geological evolution. We expect to observe a wide variety of atmospheres and planets with alternative evolutionary paths, with some planets resembling Earth at different epochs. For an Earth-like atmospheric time trajectory, we simulate planets from prebiotic to current atmosphere based on geological data. We use a stellar grid F0V to M8V (T_{eff} = 7000 K to 2400 K) to model four geological epochs of Earth's history corresponding to a prebiotic world (3.9 Ga), the rise of oxygen in the paleoproterozoic at 2.0 Ga and the neoproterozoic at 0.8 Ga, and the modern Earth. We model the atmospheric spectral features, including biosignatures, in the VIS - IR spectral through geological time for FGKM stars and the effect of clouds on the signal.

In particular, the observability of the O_2 feature for lower concentrations will depend largely on clouds, with possible degeneracies between O_2 concentration and percent cloud cover. In the prebiotic atmosphere, no oxygen is present in either the emergent flux or in relative absorption. As oxygen increases, the relative absorption depth increases from 1% to 100% present atmospheric levels of O_2, yet it isn't until the modern atmosphere that we see a notable increase in the depth of the feature in the remotely detectable spectrum due to cloud cover. We also note that the O_2 feature becomes difficult to detect for the coolest M dwarf in our sample, the M8V, even in the modern atmosphere due to low intrinsic stellar luminosity at those wavelengths.

Additional Information: This work is in review at *Astrophysical Journal* as "Spectra of Earth-like Planets Through Geological Evolution Around FGKM Stars" by S. Rugheimer and L. Kaltenegger.