Seven giant impact fallout layers in the 3.5 to 3.2 Ga Barberton Greenstone Belt: Evidence and implications

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Direct evidence for giant impacts on Earth prior to 3 billion years ago is found only in the sedimentary record within greenstone belts. Our most recent work increases the number of recognized giant impacts in the Barberton greenstone belt from 4 to 7 based on some or all of the following criteria: 1) layers >15cm thickness composed of spherical particles with structures and textures suggestive of melt droplets; 2) sedimentology suggestive of unusually energetic conditions, including tsunami waves; and 3) anomalous geochemistry such as high Ir, nickel spinels, and Cr isotopes. Size estimates for these impacts based on bed thicknesses, spherule sizes, and Ir or Cr fluxes suggest impactors from 20-100 km in diameter.

New field work and zircon U-Pb studies allow us to propose three new impact layers, and several additional layers contain evidence for smaller impacts. In the mafic-ultramafic Onverwacht Group we previously recognized an impact layer, S1 (3470 Ma), and now recognize two additional layers at approximately 3400 Ma and 3300 Ma. Both are thick layers of large impact spherules. The younger unit is unusual in the diversity of zircons, with some greater than 3800 Ma, which suggests a source outside the Kaapvaal Craton, probably at the impact target site. As yet, no shocked zircons have been identified. In addition to three previously recognized Fig Tree Group impacts, a new spherule layer dated at 3230 Ma has been identified near the top of this unit. These define a cluster between 3300-3230 Ma that includes five distinct impacts. The resolution of these impact ages is near that of U-Pb geochronology in the Archean, but each of these five layers includes distinctive characteristics suggesting the layers are not correlated.

Five giant impacts over a 70 Ma interval indicate that impact flux rates for the Archean were significantly higher than currently estimated and/or that a second short duration event similar to the Late Heavy Bombardment took place near 3300 Ma. These impacts must have played a major role in the evolution of Archean surface and tectonic systems.

Biogenic gas accumulation and release from peat soil blocks: A comparative study between northern and subtropical peat samples

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Peat soils accumulate in wetlands over a wide range of latitudes under anaerobic conditions due to partially decayed organic matter, and are considered to be one of the largest natural sources of atmospheric methane (CH_4) and Carbon Dioxide (CO_2).

Most traditional methods used to estimate biogenic gas dynamics are invasive and provide little or no information about lateral distribution of gas. In contrast, Ground Penetrating Radar (GPR) has been already proved as an emerging technique for non-invasive investigation of biogenic gas dynamics in peat soils. GPR uses electromagnetic (EM) wave propagation and reflection properties to retrieve information of the inner structure of subsurface materials. Similarly, we use GPR to non-invasively extract information of the gas regime in peat soils. We also include time-lapse measures to extrapolate information about gas dynamics in peat soils.

In this study, we use GPR in a two-antenna configuration with 1.2 GHz frequency to quantify spatial distribution and temporal changes in biogenic gasses from peat blocks of approx. 13liters from both subtropical (Everglades) and boreal peatlands. Changes in velocity of the EM wave are converted into gas content by applying a petro-physical model (the Complex refractive Index Model, CRIM) that accounts for soil porosity and water content. In addition, two-dimensional (2D) tomography is performed to better define distribution of gas bubbles within the peat blocks. GPR data is further constrained with surface deformation and gas flux measurements and contrasted with atmospheric pressure.

Our results could help better understanding the influence of latitude in the carbon dynamics of peatlands and its relation to climate change.