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P-wave velocity anisotropy in an active methane venting pockmark: The Scanner Pockmark, northern North Sea

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Scanner pockmark is an active and continuous methane venting seafloor depression of ~ 900 x 450 m wide and 22 m deep. It is located in the northern North Sea, within the Witch Ground basin where the seafloor and shallow sediments are heavily affected by pockmarks and paleo-pockmarks of various sizes. A seismic chimney structure is present below the Scanner pockmark. It is expressed as a near-vertical column of acoustic blanking below a bright zone of gas-bearing sediments. Seismic chimneys are thought to host connected vertical fractures which may be concentric within the chimney and align parallel to maximum compression outside it. The crack geometry modifies the seismic velocities, and hence, the anisotropy measured inside and outside of the chimney is expected to be different.

We carried out anisotropic P-wave tomography with a GI-gun wide-angle dataset recorded by the 25 Ocean Bottom Seismometers (OBSs) of the CHIMNEY experiment (2017). Travel times of more than 60,000 refracted phases propagating within a volume of 4 x 4 x 2 km were inverted for P-wave velocity and the direction and degree of P-wave anisotropy. The grid is centred on the Scanner Pockmark and has a y-axis parallel to -34^{o} N. The horizontal node interval is denser in the zone covered by the OBSs and the vertical node interval is denser near the seabed. A 3 iteration inversion leads to a chi^2 misfit value of 1 and a root-mean-square misfit of <10 ms. The results show a maximum P-wave anisotropy of 5%, and higher degrees of anisotropy correlates well with higher velocities. The fast P-wave velocity orientation, a proxy for fracture orientations, is 46^{o} N. The top of the chimney possibly links a bright spot mapped at 270 ms in two way travel time using RMS amplitudes of MCS data, to the surface gas emission. The bright spot corresponds to low tomographic P-wave velocity and anisotropy, suggesting that gas is located in a zone with unaligned fractures or porosity. This observation is in good agreement with early multi-channel seismic data interpretations which suggested that the gas is trapped within a sandy clay layer, the

Ling Bank Formation, capped by an upper clay layer, the Coal Pit Formation. In the next step, we will invert the travel-times of reflected phases in order to increase the image resolution.