Stoneage site detected by high resolution seismic method

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In 2014, we first noticed on high resolution seismic profiles acquired by a Teledyne high-resolution Chirp III subbottom profiler in the well-documented Stone Age settlement of Atlit-Yam, located off Israel's Carmel coast irregular disturbances in the water column and we named it "haystacks". We speculated if these disturbances could be related to the flint debitage (blades) documented at the flint workshop in the survey area. The ChirpIII instrument sweeps the frequency interval 2 kHz – 20 kHz and operate in two bands 2-8 and 8-20 KHz. Acoustic experiments in laboratory had previously shown that flint blades could exhibit resonance when exposed to certain frequencies (3–23 kHz, with the main area being 7–12 kHz). Acoustic modeling confirmed this and modelling showed that even flint debitage buried below 2 m of sand could resonance. In Demark practical ChirpIII (that sweep the frequency interval 2 kHz – 20 kHz) used on flint debitage and natural cracked flint placed at the seafloor showed that flint debitage produced "haystacks" on seismic profiles whereas the natural cracked flint did not. Test of buried debitage showed that it created resonance and produced "haystacks".

In the dredged part of the Svanemøllen Harbour, Copenhagen we by coincidence located "haystacks" while testing instrumentation setting. In the following three years, we recorded data on three days to outline the area where "haystacks" are present and to confirm that the "haystacks" were a permanent phenomenon. The interpretation of the seismic data reveal that the haystacks are related sub bottom areas characterized by shallow basins and rivers in a near coastal setting and that the "haystacks" are located at the rim of the basins or in the basins. In order to test if there was a correspondence between the "haystacks" and possible debitage 11 shallow vibrocores, with a max length of 1 m, were drilled below locations of "haystacks". Based on the cores we found up to 36 cm of silt below the dredged seafloor before we reached a sandy cover of up to 80 cm representing part of the basin configuration. The sandy interval is underlain by till clay. Two cores centrally placed in the surveyed area confirmed the presence of man knapped flint at a depth of 80-90 cm below the sea floor.

The Svanemøllen Harbour site is a hitherto unknown buried Stone Age settlement and this is the first time that such a site has been acoustically detected (Teledyne Chirp III) and verified by drilling. Acoustic modelling of the retrieved pieces of man knapped flint is carried out to confirm that the debitage can be brought to resonance.

Due to the relative sea level rise a significant part of the submerged Stone Age sites must worldwide be expected to be buried in the seafloor sediments. This paper underlines the importance of the development of cost-effective methods for detecting such buried cultural deposits.

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