

purpose is often ineffective. Rather than the time of the next earthquake, seismologists are only capable of assessing the risk of an earthquake within a time period (Marshak 2007: 234). As Marshak notes, there is a very low chance of noticing the seismic warning signs of an impending earthquake, as most foreshocks are “indistinguishable from other small earthquakes”. The recording of seismic shockwaves is, though, used for the study of earthquakes: Seismic stations worldwide constantly record seismic waves at their respective locations. By measuring the time taken for Rayleigh and Love waves, as well as P- and S-Waves, to arrive at each seismic station, the distance from the focus and epicentre of an earthquake can be calculated (Marshak 2007: 215).

Conversely, Seismology has played an integral part in the study of the Earth’s interior structure. With the known behavioural characteristics of P- and S-Waves (particularly, the velocity at which these waves travel through media of varying densities), the density of various sub-surface strata can be inferred. An example of how this has been used is in the discovery of the Earth’s molten Outer Core; it was noticed that S-Waves were not recorded on Seismic stations beyond 103° around the world from the epicentre of an earthquake. Given that S-Waves are not transmittable by liquid matter, it was inferred that the Outer Core is liquid (Marshak 2007: 244).

Assessments on the short-term likelihood of a volcanic eruption are possible with seismology. Seismics can be employed for the determination of the size of magma chambers and the density of magma, which can be used to infer the likelihood of a volcanic eruption. The potential severity of an eruption may also be predicted.

Seismic Tomography (the creation of three-dimensional models of the Earth’s subsurface through the use of seismic data from Seismic stations worldwide) has provided a detailed map of the density of the Earth’s interior, in turn validating plate tectonics theories (Marshak 2007: 246).

Seismic studies using more sensitive geophones, rather than Seismic stations, have been used to map out sub-surface stratigraphy. This can be useful for construction as well as archaeological, hydrocarbon and mineral resource prospecting. Palaeogeological studies are also aided by this form of geophysical mapping.

Seismic stratigraphy has been used for archaeological purposes for at least fifty years, although such instances are seldom. Chris Gaffney and John Gater (2006: 121) note that their own use of seismic survey at Cooper’s Hole, Cheddar, United Kingdom, as an alternative to higher-resolution and faster geophysical methods was due to rare geologic conditions which prevented the effective use of these other methods. Here, archaeologists excavating inside a cave needed information regarding the extent of a layer of clay sediment that had formed since the cave’s occupation. The survey was able to differentiate between the clay layer and the bedrock cave floor, and to provide details on the thickness of the layer of clay (Gaffney & Gater 2006: 121). However, the survey was not sensitive enough to reveal spatial information about the human and animal skeletal remains and large ceramic assemblages recovered during excavation. Seismology’s inability to resolve small, buried features prevents it from being used more often in archaeological prospecting.

Seismology is useful for archaeological purposes when any potential archaeology is believed to be buried deeper than 4 metres below the surface. At such depths, other techniques are often incapable of detecting buried archaeological

features (unless they are especially large, such as the size of a car). Seismics and electrical resistivity tomography can be adapted to work under these conditions and can be quite successful, although electrical resistivity tomography is usually preferred over seismics.

A well-established use for Seismology is for the prospection of hydrocarbon and mineral deposits. Such a survey relies on consistent velocities and behaviours of P- and S-Waves through materials of specific densities. The velocity of these waves will increase when travelling through a material of greater density than the surrounding media, and will slow when travelling through a medium of lower density. By measuring the time taken for seismic waves to be reflected by sub-surface layers, an inference may be made about the mineralogical content of the layer.

C. Hewitt Dix describes the process for data collection:

‘Seismographs [...] are laid out by the surveyor. Then we drill shot holes from 20 to several hundred feet in depth... an explosive charge is loaded at the bottom of each hole [...] and [the ordinance is detonated.]’ (Hewitt Dix 1981: 11-14).

Seismic waves created by the detonation of explosives are both reflected and refracted by the strata beneath the ground. Geophones are used to measure the waves that reach the ground surface due to both reflection and refraction; perfectly horizontal stratigraphic boundaries cause the reflection of waves while discontinuities such as fault-lines produce refraction of waves (Hewitt Dix 1981: 14). These geophones act as Seismic stations, recording the amplitude of seismic waves through time and the data is analysed as previously explained.

Finally, a different technique has been used for coal-specific prospecting for at least twenty-five years. In-seam seismic surveys differ from any other seismic survey type in that geophones are not placed on the Earth’s surface but rather within the coal seam itself. This is done in order to take advantage of coal’s unique ability to ‘guide seismic energy in the form of channel waves in the seam’ (Hatherly et al. 1985: 4). The advantage of this method is that surveys of much greater resolution are possible.

Seismology has been used extensively in the past for mapping out the major features of the Earth’s sub-surface and is regularly used for earthquake triangulation, the monitoring of volcanic activity and mineral and hydrocarbon prospection. However, seismology cannot provide the high-resolution data required for the prospection of the majority of archaeological features and is, therefore, rarely useful to the archaeologist.

References

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