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Seismic faults and sacred sanctuaries in Aegean antiquity

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ABSTRACT

The ancient destructive capability of earthquake faults is well chronicled by historians and their cultural impact widely uncovered by archaeologists. Archaeological and geological investigations at some of the most renowned sites in the ancient Greece world, however, suggest a more nuanced and intimate relationship between seismic faults and past human settlements. In the Aegean's karstic landscape earthquake fault scarps act as limestone ramparts on which fortifications, citadels and acropoli were constructed, and underlying fault lines were preferred pathways for groundwater movement and egress. The vital purifactory or therapeutic role of natural springs in the ritual practices of early settlements implies that the fault lines from which they leaked may have helped position the nascent hubs of Greek cities. Equally, the tendency for earthquakes to disrupt groundwater patterns and occasionally shut down persistent springs provides a hitherto unrecognized mechanism for the abrupt demise of those same settlements. Votive niches, carvings, reliefs and inscriptions on fault surfaces suggest important sacred sanctuaries, particularly those with oracular functions, may have been deliberately built astride active fault traces and venerated as direct connections to the chthonic realm ('the underworld'). Regionally, the Aegean's distributed network of tensional faulting, circulating geothermal waters and deep-seated de-gassing sets the tectonic framework for the springs and gases that infuse the ancient Greek netherworld of caves, chasms, chambers, and sacred grottos. The possibility that seismic faults may have constituted the fulcrum of prominent sacred places means that, for all their obvious destructiveness, earthquakes may have had an unacknowledged cultural significance in Greek antiquity.

1. Introduction

Throughout human history in the eastern Mediterranean region, urban settlements have co-existed with earthquakes (de Boer and Sanders, 2006). The destructive capability of seismic activity is well chronicled by historians (Ambraseys, 1971; Guidoboni et al., 1994), and its cultural wreckage widely uncovered by archaeologists (Karcz and Kafri, 1978; Rapp, 1986; Nikonov, 1988; Stiros and Jones, 1996; Sintubin et al., 2010; Jusseret and Sintubin, 2017). Accounts and observations of seismic damage to ancient constructions and relics offer partial information on the size, location and date of ancient earthquakes (Sintubin and Stewart, 2008). Buildings and structures damaged by shaking or offset across faults provide archaeological markers that can shed light on the slip history of possible seismogenic sources (e.g. Marco et al., 1997; Ellenblum et al., 1998; Galli and Galadini, 2003; Korjenkov et al., 2003; Sbeinati et al., 2010; Passchier et al., 2013) and can inform regional seismic hazard (Sintubin et al., 2008; Jusseret, 2014; Jusseret and Sintubin, 2012; Jusseret et al., 2013).

Any tendency for active faults to disrupt former urban settlements might seem to be an unfortunate situation that arose spuriously as a consequence of past populations, ignorant of seismic threats, being unwarily drawn to these invisible axes of destruction. The lure of these lethal corridors of land reflected the surprising advantages that tectonically active belts offer; active faults can create and sustain attractive conditions for human development, sustaining dynamic landscapes in which recent tectonics 'frame' patterns of human land use (Bailey et al., 1993; King et al., 1994; King and Bailey, 2010). Groundwater leakage and sediment build up along young fault lines provide well-watered corridors of land, leading some to conjecture that active tectonic zones seeded the earliest centres of Neolithic agriculture (Trifonov and Karakhanian, 2004) and even of early civilisations (Force, 2008; Force and McFadgen, 2010, 2012). Moreover, the tendency for active fault lines to provide persistent groundwater egress and fertile land over millennia lies at the root of the 'fatal attraction' that today finds many populous towns and cities across the eastern

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Mediterranean and Near East lying directly above seismically dangerous faults (Jackson, 2005).

In this paper, an association between active faults and ancient places is examined in the context of some of the most prominent sites of Greek antiquity. A close correspondence of active faults and ancient cities here is not unduly surprising – the Aegean region is riddled with seismic faults and littered with ruined settlements, so some casual correlation is to be expected. But the correlation would appear to be more than simply a contiguous association – across central Greece and western Turkey many seismic fault traces do not simply disrupt the fabric of buildings and streets but rather they penetrate sacred sanctuaries at heart of ancient urban settlements. At Priene on the Menderes graben in western Turkey, for example, a narrow corridor of seismic damage cuts the Hellenistic city centre, rupturing a series of public buildings that include the Sacred Stoa (Altunel, 1998; Altunel, 1999; Yonlu et al. 2010). Further south, the expansive Greco-Roman remains of Sagalassos sprawl in front of an active fault escarpment, with the most recent fault splay cutting the temple complex in the centre of the city (Sintubin et al., 2003; Similox-Tohon et al., 2006). In the following sections, the key relations between seismic faults and sacred sanctuaries in the wider Aegean region are set out, and the implications for earthquakes as a pervasive cultural influence in antiquity are discussed.

2. Scarps and springs: the example of Mycenae

In the Aegean sector of the Mediterranean, active normal faulting operates within a largely carbonate-dominated karstic landscape. Repeated vertical fault movements form limestone scarps, which in the physical landscape separate the rocky karstic uplands from the soil-rich plains (Stewart and Hancock, 1988; Stewart, 1993) (Fig. 1). These abrupt linear bluffs – metres to several tens of metres high and fronted by smooth surfaces polished by repeated seismic slip (Stewart, 1993, 1996a) – serve as natural ramparts on which fortifications, citadels and acropoli were constructed. In addition to forming advantageous topographic positions, across the limestone terrain of Greece and western Turkey, copious and persistent cold and hot mineral springs preferentially emerge along active faults (Higgins and Higgins 1996). In turn, because the waters harvested from them not only supplied a range of early water management practices but were also essential for purifactory or therapeutic purposes, it has been argued that early Greek settlements were purposefully centred on natural fountains and springs (Crouch, 1993).

An instructive example of the strategic benefits accrued from living on an active fault is found at Mycenae, in the eastern Peloponnese region of mainland Greece (Zangger, 1993). The famed Mycenean hillltop citadel is bounded by metre-high limestone fault scarps on its southwestern and northeastern sides, and its formidable 'Cyclopean Walls' partly built on top (Maroukian et al. 1996) (Fig. 2). The southwestern scarp is the more obvious, bordering the famed Lion's Gate entrance (Nur and Cline, 2000). The longer and more continuous northeastern strand, however, is arguably the more significant structure because it hosts the 'Sacred Spring' (Maroukian et al., 1993), one that although located just outside the citadel could be accessed from within the city walls via a subterranean passageway that tapped the fault zone. Maroukian et al. (1993) argue that it is this fault that ruptured during Mycenean times causing widespread destruction of the citadel (Kilian, 1996), a reminder that the strategic advantage of living atop an active fault could be negated by the ruinous effects of seismic reactivation directly below.

3. Earthquake hydrology and the curious case of Perachora Heraion

If natural springs are important for the functioning of Greek settlements then the loss of reliable groundwater sources might equally be a cause for the abandonment of those same sites (e.g. Gorokhovich, 2005). Large earthquakes are known to cause significant reorganisation of the pattern and rate of groundwater flow (Muir Wood and King, 1993; Rojstaczer et al., 1995; Yechieli and Bein, 2002; Manga and Wang, 2015). In the Aegean region, for example, the destructive 1894 earthquake along the shores of the Gulf of Atalanti caused freshwater springs to cease flowing, only to later return with their flow doubled, whilst coastal groundwater springs became muddy and brackish (Cundy et al., 2000). Such abrupt changes to groundwater can be transient and quickly recovered, but occasionally earthquakes cause the permanent termination of persistent springs and provoke new springs to burst forth elsewhere (Muir Wood and King, 1993). Finding archaeological evidence for settlements whose springs were lost to ancient earthquakes is difficult, but a possible candidate lies at the eastern end of the Gulf of Corinth, at Perachora Heraion.

The ruined Classical Greek sanctuary of Perachora Heraion occupies the westernmost tip of the Perachora Peninsula, a fault-bounded promontory projecting into the eastern Gulf of Corinth (Leeder et al., 2005). The sanctuary – a temple complex for the goddess Hera initiated around the 9th century BC – is an enigmatic Classical site (Tomlinson, 1976). It was largely unknown prior to its excavation in the 1930s by the British archaeologist Humphry

Fig. 1. Repeated earthquake faulting in the limestone terrain of Greece and Western Turkey form distinctive fault scarps sllong the edges of many alluvial plains. These limstone fault scarps serve as natural ramparts on top of which fortifications, citadels and acropoli were constructe and are often lines of preferential spring egress.

Fig. 2. The formidable 'Cyclopean Walls' of the hillltop citadel of Mycenae are built atop metre-high limestone fault scarps, with the southeastern one bordering the famed Lion's Gate entrance (a) and the northeastern one that lies along the line of the sacred Spring (b).

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