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EARTHQUAKE LIGHTS IN LEGENDS OF THE GREEK ORTHODOXY

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ABSTRACT

Local legends may contain information about real geological events of the past. Earthquake lights (EQL) can occur in the atmosphere over earthquake epicenter areas and adjacent faults before and during quakes. They may look like diffuse airglow, flashes, fiery pillars, and luminous balls. EQL may cause a mystical experience probably due to the influence of their electromagnetic fields on the brain. Subjective perception and interpretation of EQL depend on religious and cultural traditions. We study a stereotype of EQL interpretation in the legends of the Greek Orthodoxy exemplified by the legends about the foundation of two shrines: St. George Monastery near the Cape Fiolent, Crimea and the Panagia Tripiti Church in Aigion, Peloponnese. It is argued that the similar interpretation of EQL observation in the Crimean and Peloponnesian legends were caused by similar natural and economic living conditions of the Greek population in the both regions in the Middle Ages. We also consider some examples of EQL observation took place in other regions and their interpretation in other denominations. Differences and relations between EQL of mechanoelectrical and degassing origin are discussed. Finally, we consider the role of active faults in the production of a mystical experience and sacralization of an affected landscape.

KEYWORDS: Earthquake, seismicity, fault, neurophysiology, legend, religion, mystical experience.

1. INTRODUCTION

Local myths and legends may contain verifiable information about real geological events of the past (Vitaliano, 1973; Bentor, 1989; Piccardi and Masse, 2007). This allows one to conduct research combining expertise and methods of geology, history, archaeology, anthropology, and other sciences. Piccardi (2007a, p. vii) explained the importance of such interdisciplinary studies as follows: "The geological study of mythology and legendary accounts may reveal encoded memories of past geological events, thus providing a reservoir of geological information. On the other hand, it also helps to provide new insight to historical, archaeological and anthropological research, opening a new window on a field traditionally reserved for anthropologists".

Immediately prior to and during earthquakes one may sometimes see diffuse airglow, flashes, glare, and short-lived linear or quasi-spherical luminous objects (e.g., fiery pillars and luminous balls) in the atmospheric boundary layer over quake epicentre areas and adjacent active or reactivated faults. These phenomena are collectively known as earthquake lights (EQL) (Derr, 1973; Papadopoulus, 1999; Thériault et al., 2014). The mechanism of their generation is not completely clear. It is argued that during earthquake preparation processes, the increase of local and regional lithospheric stresses may lead to mechanoelectrical phenomena. In particular, when rocks are mechanically stressed they can cause electric currents due to electron hole charge carriers (Freund et al., 2006, 2007). Prior to relatively strong earthquakes (magnitude > 4), such currents in adjacent faults can cause air ionisation and corona discharges (St-Laurent et al., 2006).

According to the Derr–Persinger hypothesis (tectonic strain theory), EQL formation is connected with the rise of local and regional lithospheric stresses (Persinger, 1976, 1980, 1984; Derr and Persinger, 1986). EQL are frequently observed near active faults and fault-controlled river valleys during minor seismic events (magnitude < 2) days or months ahead of a stronger earthquake. EQL can move along fault lines, probably, due to the redistribution of a lithospheric stress (Persinger and Derr, 1985, 1990a; Derr and Persinger, 1990). As a result, EQL can be observed not only over epicentres, but also over associated active or reactivated faults at a distance of up to several hundred kilometres from an epicentre (Persinger and Derr, 1990b). EQL characteristics, such as colour, size, luminous intensity, and occurrence frequency depend on the local geological situation (i.e., rock magnetic susceptibility), the presence of magnetic anomalies, and topography.

EQL may induce a range of temporary dysfunctions, acute and chronic diseases, and death depending on the observation time and energetic characteristics of EQL and the distance between the EQL and an observer (Persinger, 1983, 1988). This is probably due to the impact of electromagnetic fields of EQL (it is well known that electromagnetic fields may influence an organism – Yakovleva, 1973; Marino and Becker, 1977; Palmer et al., 2006). In certain circumstances, EQL may affect the psyche and probably cause a mystical experience.

Mystical experience is a sort of altered state of consciousness characterized by visual and auditory hallucinations, including apparent contacts with divine or supernatural creatures. These contacts are often accompanied by extreme emotions, such as delight, euphoria, horror, panic, etc. (James, 1902; Maslow, 1964; Tortchinov, 1998; Levin and Steele, 2005). Like other forms of altered states of consciousness, a mystical experience may be both spontaneous and induced (Vaitl et al., 2005). Various accidental and goal-oriented exposures may result in mystical experiences, such as drugs, intoxication, fasting, magnetic and electromagnetic fields, extreme conditions in polar regions, deserts, and high mountains, hypoxia, hyperventilation, physical and emotional overloads, injuries, etc.

In the context of this article, it is essential that a mystical experience may be induced by magnetic fields. For example, numerous experiments have demonstrated that a short (3–5 min) transcranial exposure of the right hemisphere to an extremely low frequency weak magnetic field (0.5–10 Hz, 0.1–5 μT, the signal has a complex pulsed form) evokes an experience of the sensed presence in 80% of the general population (Johnson and Persinger, 1994; Cook and Persinger, 1997; Persinger and Healey, 2002; Booth et al., 2003; St.-Pierre and Persinger, 2006). The sensed presence consists in the feeling or apparent observation of a supernatural creature located near the observer.

EQL are known in all cultures. Subjective perception and interpretation of EQL depend on religious and cultural stereotypes of an individual and society. Sites of EQL watching are becoming places of worship; churches and monasteries are often built in such sites (see examples in Section 3.2). In this paper we study a stereotype of EQL interpretation in legends of the Greek Orthodoxy exemplified by the legends about the foundation of two places of worship: St. George Monastery near the Cape Fiolent, Crimea and Panagia Tripiti Church in Aigion, Peloponnese (Fig. 1).

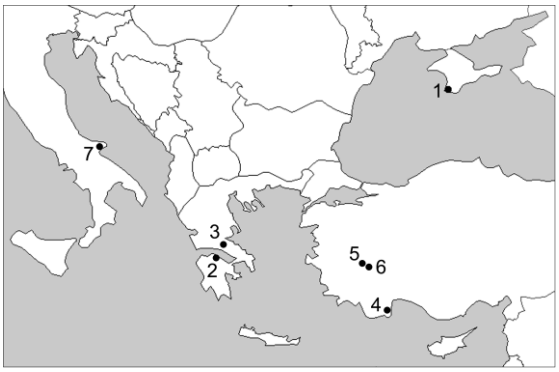

Figure 1. Geographical position of some sites discussed in the paper: 1 – Cape Fiolent, 2 – Aigion, 3 – Delphi, 4 – Chimaera, 5 – Hierapolis, 6 – Colossae, 7 – Monte Sant'Angelo

2. DESCRIPTION OF TWO SITES

2.1 St. George Monastery near the Cape Fiolent, Crimea

According to the local legend (Nikon, 1862, p. 7), Greek fishermen were caught by a heavy storm in the sea nearby the Cape Fiolent in the year 891. The storm drove their ship toward sea rocks. They suddenly noticed St. George the Conqueror within a fiery pillar on top of a sea rock. Immediately afterwards the storm subsided. The rescued crew climbed the rock and found an icon of St. George. In memory of this event, a monastery was founded on the steep rocky cliff and the cross was installed on the rock (Figure 2). According to current data, the Balaclavian St. George Monastery was founded no earlier than the late 14th century; the present cross was installed in the post-Soviet period (Tur, 2006, pp. 101–105).

Figure 2. The St. Appearance Rock near the Cape Fiolent, the view from the St. George Monastery

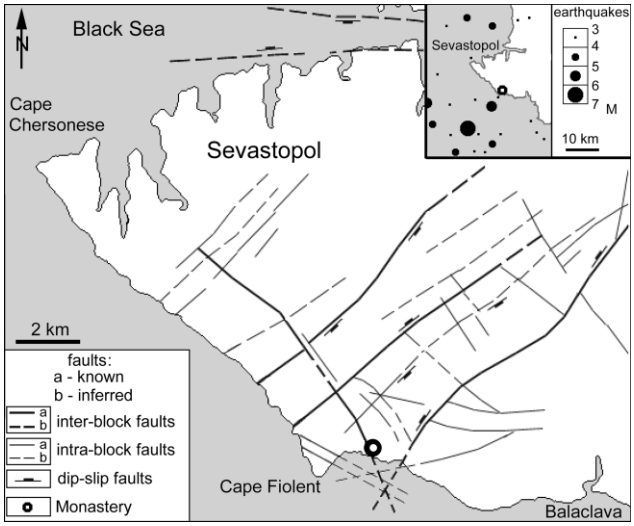

Figure 3. The Cape Fiolent area: faults and earthquakes with magnitudes > 3 from 1927 to 1985 (Borisenko et al., 1982; Borisenko, 1986; modified from Florinsky, 2010, p. 229)

The legend apparently describes the EQL observation and associated mystical experience (Florinsky, 2010, pp. 236–237). Indeed, the local geological environment and regional seismic activity are favourable for EQL occurrence: There are several intra- and inter-block faults on the land in proximity to the monastery (Borisenko et al., 1982) (Figure 3). There are perhaps offshore extensions of the faults and a complex offshore node of their intersection at a distance of 1 km from the monastery. The Cape Fiolent cliffs are composed of volcanic rocks containing magnetite (Pechersky et al., 1991). There are intensive striped magnetic anomalies ranging from 1,200 to -800 nT on the shelf between the Cape Chersonese and the city of Balaclava probably caused by intrusive bodies associated with faults (Gorodnitsky et al., 1967).

The region is marked by the high seismic activity: there is the Sevastopol quake epicentre group located to the southwest of the Cape Fiolent at the distance of 10–30 km from the coast (Borisenko, 1986) (Figure 3). There were EQL cases in the region: fiery flares and pillars in the sea have been seen from the shore from the west to the southeast coasts of Crimea during the 1927 Crimean earthquakes (Nikonov, 2002).

The St. Appearance Rock (Figure 2) is a dome-shaped subvolcanic body composed of keratophyres. It is located in one of the intersections of local faults (Solovyev, 1988). It is known that EQL are often observed above tops of hills (Persinger, 1976). In the case of the apparition of St. George, this rock protruding from the water could play the role of the top of the hill.

2.2 *Panagia Tripiti Church in Aigion, Peloponnese*

According to the local legend (Holy Metropolis of Kalavryta and Aigialeia, 2000), a shipwreck happened at night in the sea near the city of Aigion in the south coast of the Gulf of Corinth in the year 1550. The drowning sailor saw the light on the shore. Swimming to the light, he got ashore and found a small grotto in the slope of the coastal scarp, in which there was a shining icon of the Virgin Mary. The rescued sailor made a vow to build a chapel on this site. Since the grotto was too small, he began building a bit aside. However, on the first night after the work began, the small grotto miraculously increased. It became possible to make a small cave church within the grotto and place there the icon. The present size of the grotto is about 11 × 7 m; its height is about 4 m. The church built around the grotto (Figure 4) acquired its present appearance in the 19th century.

Figure 4. The Panagia Tripiti Church in Aigion; the steep coastal scarp is behind the church

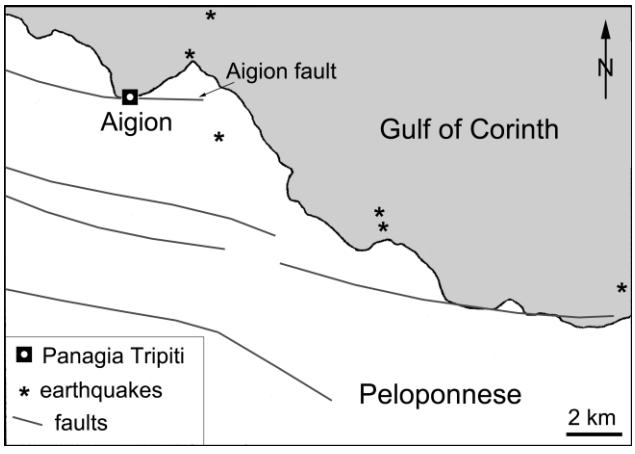

Figure 5. The Aigion area: faults and earthquakes with magnitudes 6–7 from 373 BC to 1995 (Koukouvelas and Doutsos, 1996; Soter, 1999)

We believe that the legend describes the EQL observation and associated mystical experience. Local geological conditions and regional seismic activity are favourable for EQL generation: The Gulf of Corinth Rift is one of the most seismically active Mediterranean regions (Ambraseys and Jackson, 1997). From 373 BC to 1995, there were at least 9 earthquakes with magnitude 6–7 within the radius of 20 km from Aigion (Koukouvelas and Doutsos, 1996) (Figure 5). Local residents on the both sides of the gulf observed EQL (Soter, 1999) during the 1995 Aigion earthquake (magnitude 6.2, the epicentre was in the gulf – Koukouvelas and Doutsos, 1996).

The Aigion fault, topographically manifested and reactivated during this earthquake (Koukouvelas and Doutsos, 1996) (Figure 5), crosses the city and forms the high coastal scarp (Unkel, 2002, p. 32). The scarp is composed of delta conglomerates. The back wall of the Panagia Tripiti Church is based on the steep slope of the scarp (Figure 4), that is, the church and grotto, where the icon was found, are directly located on the fault. The legendary enlargement of the grotto has likely happened due to a small seismogenic collapse of the relatively soft and unstable rocks.

3. DISCUSSION

3.1 *Stereotyped interpretation of EQL in the legends*

One can see almost identical interpretation of the EQL observation in the both legends, the Crimean and Peloponnesian ones. We believe that this is connected with similar natural and economic living conditions of the Greek population in these territories in the Middle Ages.

First, migration and settlement of the Greeks in the basins of the East Mediterranean and the Black Sea generally occurred in terrains with fairly close geomorphological and geological environments, as well as similar geodynamic and seismic situations (Trifonov et al., 2002). We can assume that seismogenic EQL were periodically observed throughout the Greek World.

Second, coastal navigation and fishing was one of the main activities of the Greek population of these territories. Therefore, it was a typical situation when sailors and fishermen caught in a storm in the dark.

A sudden appearance of EQL in the dark over the rocks in the sea or coastal cliffs could really help sailors in orientation. It is clear that sailors could see such an event as a miracle even without possible effects of EQL electromagnetic fields on the brain. If the impact of electromagnetic fields occurred, it was imposed on obvious physical and mental overloads of an organism in conditions of a storm and ship-

wreck. Such a combined impact of harmful factors could increase a probability for a mystical experience, which context was naturally determined by the Orthodox topics.

After rescuing sailors certainly went to a local church to give thanks to the Lord, to report the incident, and to hear an explanation of a priest. Since an incident described by sailors could be periodically repeated, a priest's explanation could also eventually become stereotyped. In this case, a story of a subjective mystical experience of sailors ('observation' of a saint and/or an icon) could be added to a description of a real event (EQL observation and rescue). Such a stereotypical interpretation could be 'officially' adopted and disseminated by the Patriarchate of Constantinople. Subsequent sacralization of the place of the EQL observation, construction of a chapel, church, or monastery was a matter of time.

3.2 *Other religious interpretations of EQL*

Let us consider some examples of EQL observation took place in other regions (Figure 1) and their interpretation by persons of other denominations.

One of the most famous EQL observations was probably the event described in the Jewish tradition as the apparitions of the Angel and Yahweh to Moses in the burning bush near Mount Sinai (Exodus 3:2–4:17). The Sinai Orthodox St. Catherine Monastery was later founded at this place (Figure 6).

Figure 6. St. Catherine Monastery, the view from Mount Sinai

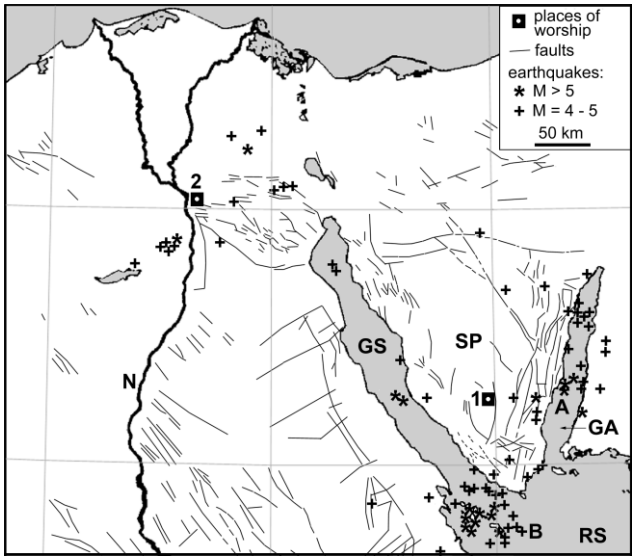

Figure 7. Egypt: faults and earthquakes with magnitudes > 4 from 1900 to 1995 (Egyptian Geological Survey and Mining Authority, 1981; Badawy and Horváth, 1999). 1 – St. Catherine Monastery in Sinai, 2 – St. Mary Church in Cairo. Earthquake epicentre groups: A – near the town of Dahab; B – southward from Sinai. SP – the Sinai Peninsula, N – the Nile, GS – the Gulf of Suez, GA – the Gulf of Aqaba, RS – the Red Sea

Local geological conditions and seismic activity are favourable for EQL emergence. Although the most part of the Sinai Peninsula is aseismic, there is the seismic activity in its edges (Badawy and Horváth, 1999). It is mainly associated with the development of two large extensional tectonic structures, the Gulf of Suez Rift and the Gulf of Aqaba Rift. There is a group of quake epicentres with magnitude 4–5 near the town of Dahab, between St. Catherine Monastery and the Gulf of Aqaba as well as in its waters (Figure 7). The distance from the monastery to these epicentres is 50–80 km. The monastery is located 2 km from a regional topographically expressed north-striking fault, a piece of the fault system associated with the development of the Gulf of Aqaba Rift (Figure 7).

From April 1968 by May 1971, thousands of people belonging to different religions, have seen and filmed luminous phenomena above the Coptic Orthodox St. Mary Church in Zeitoun, Cairo, Egypt (Swann, 1996, ch. 19): relatively large and immobile corona-discharge EQL were interpreted as the Virgin Mary, as well as small fast-moving EQL were interpreted as 'doves'. To commemorate these events, one of the largest Middle Eastern Cathedrals was built in front of St. Mary Church in the late 1970s.

These phenomena were apparently the EQL series caused by a sharp increase of seismic activity in 1969 in the waters of the Red Sea southward from Sinai (Derr and Persinger, 1989), at the junction of two rifts, the Red Sea Rift and the Gulf of Suez Rift (Fig-

ure 7). In 1969, 38 earthquakes with magnitude 3–7 occurred in this area that is 10 times greater than the usual annual number of earthquakes in this seismically active zone. Although Cairo is located about 400 km northwestward, there is a system of regional northwest-striking faults between the northern extremity of the Gulf of Suez and Cairo (Fig. 7). We suppose that these faults, being marginal manifestations of the Gulf of Suez Rift, could participate in the redistribution of regional lithospheric stresses in 1968–1971.

In 1992, there were EQL observations at the Greensides' farm near the village of Marmora, Ontario, Canada. They were interpreted as apparitions of Christ and the Virgin Mary. The farm became the Catholic pilgrimage place. These phenomena were caused by (a) the increased regional seismic activity in 1990–1997, and (b) the rise of local lithospheric stresses due to slow flooding of the open pit on the magnetite deposit situated at 2 km from Marmora. Pulsed magnetic field variations with periods of 1–7 s and 10–950 nT amplitudes were measured within the local magnetic anomaly associated with the ore body (Suess and Persinger, 2001).

It is known two Mediterranean legends about the Archangel Michael apparitions in fiery pillars: at Colossae, Turkey in AD 60 (Piccardi, 2007b) and Monte Sant'Angelo, Foggia, Italy in AD 493 (Piccardi, 2005). In the both cases, the phenomena have taken place directly on the local active faults during severe earthquakes clearly described in the legends. This strongly suggests that the legends tell us about EQL observations. The detailed description of the legends and geological settings of the sites can be found elsewhere (Piccardi, 2005, 2007b).

There is a set of phenomena observed in seismically active regions, accompanied by the luminous effects, and interpreted by Catholics as apparitions of the Virgin Mary (e.g., at Lourdes in 1858 and Fátima in 1917 – Swann, 1996). We suppose that these events can be also re-interpreted as EQL.

3.3 EQL and gas emission

In Introduction, we mentioned mechanoelectrical hypotheses of EQL generation. However, it is possible that at least a part of EQL are spontaneous combustions of natural gases containing hydrocarbons, which seep from the depths of the lithosphere through faults prior to and during seismic events (Nikonov, 2002). Indeed, short-term manifestations of degassing were recorded prior to and during the 1927 Crimean, the 1993 Patras, and the 1995 Egion earthquakes, such as bubbling of the seawater, significant increase of its temperature, and saturation of its top layer and surface air with hydrogen sulphide (Soter, 1999; Nikonov, 2002).

It is generally possible to obtain a mystical experience because of intoxication by gases (e.g., hydrocarbons, hydrogen sulphide, or carbon dioxide). In the East Mediterranean there are at least three known ancient places of worship which sacralization has been connected with the gas emission, namely: the Hephaestus Temple in Chimaera, Turkey (De Boer et al., 2007; Hosgormez et al., 2008; Etiope et al., 2011), the Apollo Temple in Delphi, Greece (Piccardi, 2000; De Boer and Hale, 2000; Etiope et al., 2006; Liritzis and Castro, 2013), as well as the Apollo Temple (and Plutonium) in Hierapolis, Pamukkale, Turkey (Piccardi, 2007b; Castro et al., 2015). In Chimaera, the landscape sacralization has been associated with the constant burning of dozens of natural gas fires on a vast area of the rocky slope of the Yanartash hill (Figure 8). In Delphi and Hierapolis, trance of pythonesses has been induced by intoxication by gases emanated from cracks in sanctuaries directly located at the local active faults.

Nevertheless, it would be counterproductive to mix EQL of mechanoelectrical and degassing origin. Presumably, there are two types of EQL. It is possible that corona-discharge and fireball EQL, which may occur above faults, can generate fiery pillar EQL by burning gases seeping from these faults.

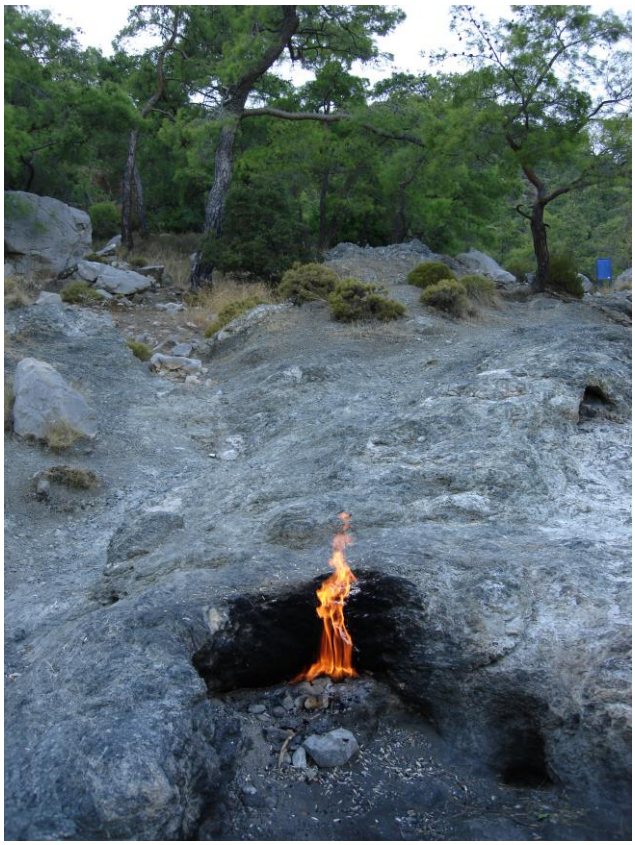

Figure 8. Chimaera, one of the natural gas fires

3.4 Faults, EQL, and worship places

Materials presented indicate a special role of active faults in the production of a mystical experience and sacralization of an affected landscape. Indeed, Piccardi (2001) found that some ancient sanctuaries are directly located on local active faults. He suggested that some sites lying along faults and marked by coseismic surface cracks and gas emission have been interpreted as Hades' Doors and thus worshiped.

The analysis of the statistically representative sample of the Crimean medieval monasteries (104 objects) and geological data demonstrated that almost all shrines are situated along faults of various ranges or at their intersections (Florinsky, 2010). We proposed the hypothesis that particular places are sacralized due to a combination of geoenvironmental factors including (a) regional and local active faults, (b) local magnetic anomalies, (c) regional and local lithospheric stresses, and (d) regional seismic activity. The factors work as follows: There is an increased permeability of the lithosphere along faults and at fault intersections over geological time scales. It creates favourable conditions for development of ore and magmatic bodies generating local magnetic anomalies. Geomagnetic storms modulate the intensity of the geomagnetic field at these anomalies. Prior to earthquakes, the rise of local and regional lithospheric stresses lead to mechanoelectrical phenomena in rocks, which also modulate the intensity of magnetic anomalies and sometimes produce EQL. Local fluctuations of the geomagnetic field and EQL electromagnetic fields influence the brain leading to a mystical experience. All four geoenvironmental factors are rather stable in time and space. This provides an opportunity to produce repeated mystical experiences at a particular site, which eventually becomes a place of worship (Florinsky, 2010).

4. CONCLUSIONS

Subjective perception and interpretation of EQL depend on religious and cultural traditions. The similar interpretation of EQL in the legends originated in two regions, Crimea and Peloponnese, situated quite far from each other, were caused by similar natural and economic living conditions of the Greek population in the both territories in the Middle Ages.

The results show that the application of geological and neurophysiological expertise to the analysis of local legends allows one to reconstruct past events associated with seismic activity. On the one hand, this can help in regional geological researches, on the other – provides additional opportunities for historical, anthropological, and religious studies.

Notice that we analysed certain aspects of the geoenvironmental impact on the human psyche and behaviour, which have a significant influence on the culture and society. The results cannot be used to evaluate the hypothesis of the existence of God, and are not intended to 'revise' sacred texts.

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