ARE RED WOOD ANTS EARTHQUAKE PREDICTORS ?

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According to Berberich et al. (2013), Red Wood Ants (RWA) of the Formica Rufa group have mounds placed along tectonically active extensional faults. The same authors correlated RWA daily activity to local seismic events. They claimed the ants have a well-identifiable standard routine that can be disturbed hours before small local earthquakes magnitude around 3, located at the seismically active Neuwied Basin in the Eifel region of western Germany. The disturbance of the RWA activity consisted in a suppression of the nocturnal rest phase the night before the earthquake. The standard daily routine resumed the next day after the local small earthquake has been recorded.

We tried to reproduce the studies related to RWA activity performed in the Neuwied Basin of Germany this time in the Vrancea seismically active region of Romania. The RWA mounds have been mapped along faults situated in the Covasna area, in the interior of the Carpathian Arc Bend. The epicentral area of intermediate-depth earthquakes in Vrancea is situated at the Carpathian Arc Bend. The recent vertical position of the subducted slab detached from the Vrancea crust represents the final rollback stage of a small fragment of oceanic lithosphere (Linzer, 2013). As the fragment of oceanic slab collapsed into the asthenosphere in a vertical position it rolled back through the mantle. The rollback is suggested by a line of seismic activity Intorsura Buzaului-Sfantu Gheorghe-Valea Zalanului at 50-100 km depth (Figure 1).

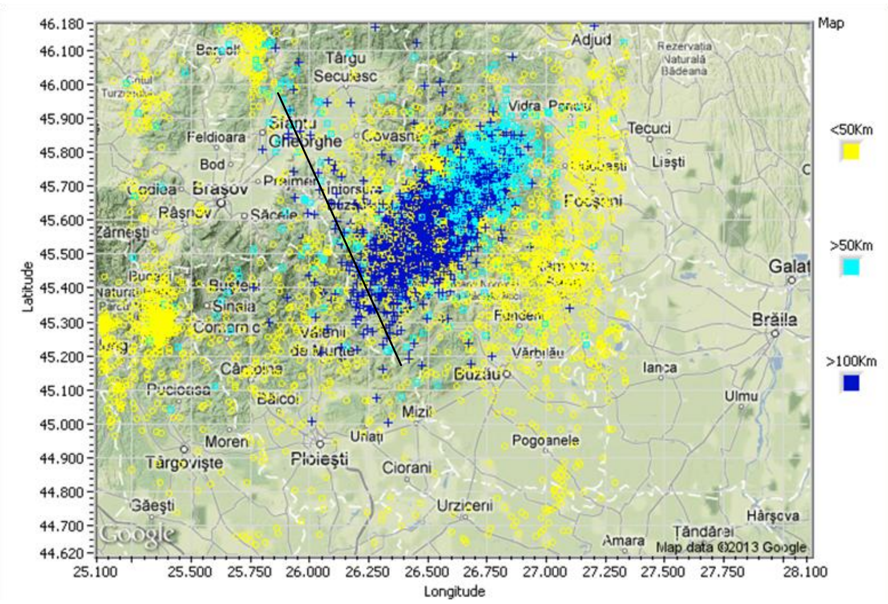

Figure 1. Seismic activity in Intorsura Buzaului-Sfantu Gheorghe-Valea Zalanului region

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This slab rollback pulled the upper crust with it, causing an extension in the overlying crust with small basin and extensional fault formation. The Horgasz Fault in Covasna is such an extensional fault generated about ten million years ago when the active subduction terminated and the rollback process started (Ismail-Zadeh et al. 2012). The Horgasz Fault is circulated by carbon dioxide and radon gas (Apostol and Iancu, 1977-1978). RWA mounds are aligned along this fault. The system of extensional faults in Covasna have been mapped based on seismic, carbon dioxide and electrical prospecting (Apostol and Iancu, 1977-1978).

We started RWA monitoring on Horgasz Fault on November 22, 2013. To indicate RWA activity we used the Berberich et al. (2013) scale from 1 (lowest activity) to 7 (highest activity). In the first stage during November 2013-March 2014 we used a manual estimation by observing RWA activity every hour. Further we intend to install a high-resolution automatic camera monitoring RWA activity continuously 24/7. Early results showed a dependence of the activity on solar radiation (nebulosity), temperature, and rainfall. (Figure 2).

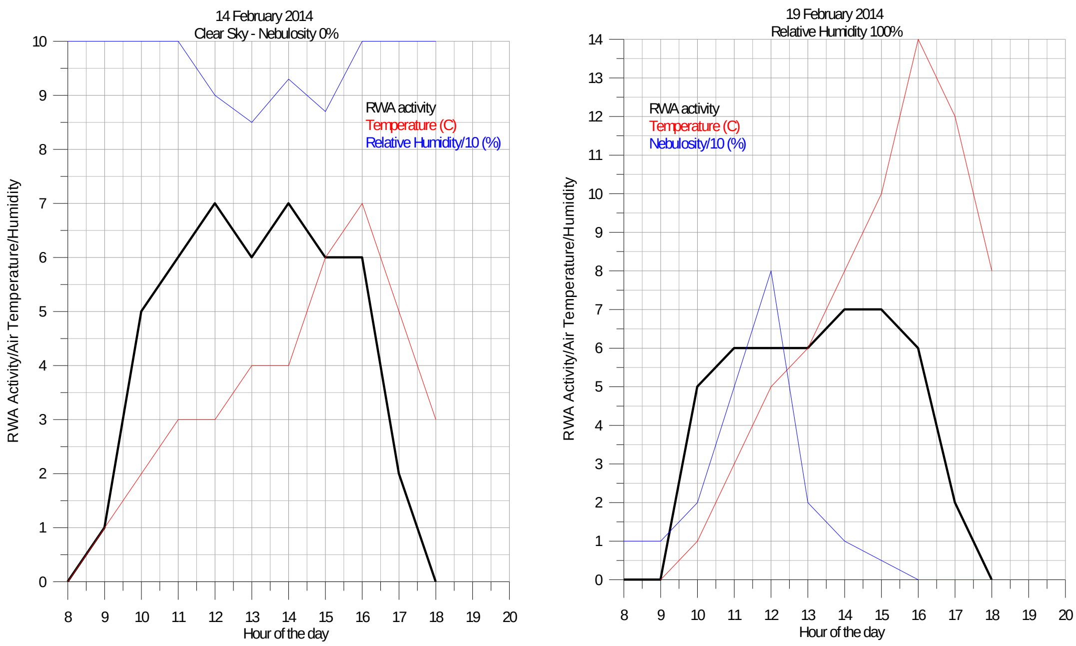

Figure 2. RWA activity correlated to meteorological factors (Temperature, Relative Humidity and Nebulosity)

The ant behavior (Figure 3) has a permanent variation related mainly to seasonal and meteorological factors.


Figure 3. RWA activity 6, at 12 AM on 19 February 2014

When meteorological factors have been constant a daily routine was established. No correlation to seismic activity magnitude around 3 has been observed. However, the mapping of RWA mounds in the Covasna area confirmed Berberich et al. (2013) main observation related to the RWA location along extensional faults circulated by carbon dioxide, radon, helium and other gases. Some other RWA mounds in Covasna area were not located on faults, but along underground shallow streams of water moving towards springs.

Holldobler and Wilson (2009) regarded ants as cellular automata, defined as agents programmed to function interactively as a higher-level system. Through the combined senses of its members the RWA colony operates as an information-processing system and respond to any challenge from their environment. If their environment challenges the ants (such as locating an adequate mound site, or any change in sun brightness, temperature, or humidity) the algorithms of individual behavior contain the solution. Based on our data small local earthquakes with magnitude around 3 do not challenge the ants. Correlations with much larger and destructive earthquakes are necessary in order to see if ants are earthquake predictors or not.

The monarch butterfly fall migration in North America from the US-Canadian border region to a forest of pines in central Mexico more than 3000 km away, might explain why RWA mounds show a tendency to be located along faults. Both butterflies and ants have organically synthesized magnetite in their antennae (MacFadden and Jones, 1985). However, this does not explain why a butterfly from New York State flies southwest towards central Mexico while the one from Minnesota flies south to the same place (Malcolm and Zalucki, 2011). A tectonic map of North America indicates a system of faults converging from a wide area in the United States to a narrow region of central Mexico (Reinemund et al., 1982). Butterflies might follow the faults in their fall migration similar to the ants placing their mounds along faults. The fault detection can be explained by magnetotelluric (MT) phase splitting (Heise et al., 2006). The authors describe MT phase splits (MTPS) as a consequence of spatial differences or gradients in conductivity. MTPS is similar to the shear-wave splitting (SWS) due to the birefringence created by the fault. RWA and monarch butterflies are able to use their antennae as a fault detector. If monarch butterflies use such a mechanism for their fall migration from the United States to central Mexico, RWA might use MTPS for their orientation around the mound. The role of the antennae in monarch orientation has been discovered by Reppert et al. (2010).

REFERENCES

Berberich G, Berberich M, Grumpe A, Wohler C, Schreiber U (2013) "Early results of three-year monitoring of Red Wood Ants behavioral changes and their possible correlation with earthquake events" *Animals*, 3, 1: 63-84

Heise W, Caldwell TG, Bibby HM, Brown C (2006) "Anisotropy and phase splits in magnetotellurics" *Physics of the Earth and Planetary Interiors*, 158: 107-121

Holldobler B, Wilson EO (2009) Super-Organism: The Beauty, Elegance, and Strangeness of Insect Societies, W W Norton & Company, New York, London

Iancu V, Apostol A (1977-1978) "Corelatia dintre tectonica, apele mineralizate si bioxid de carbon in zona Covasna", *Dari de seama ale sedintelor Institutul de Geologie si Geofizica, Vol LXV Tectonica si Geologie Regionala*

Ismail-Zadeh A, Matenco L, Radulian M, Cloetingh S, Panza G (2012) "Geodynamics and intermediate-depth seismicity in Vrancea: Current state of the art", *Tectonophysics*, 530-531: 50-79

Linzer HG (2013) "Kinematics of retreating subduction along the Carpathian Arc, Romania", *Geology*, October 2013: 1-15

MacFadden B, Jones SJ (1985) "Magnetic butterflies: A case study of the Monarch" , *Geobiology*, 5: 407-415

Reinemund JA, Terman JM (1982) Plate-Tectonic Map of the Circum-Pacific Region: Pacific Basin Sheet, American Association of Petroleum Geologists, Box 979, Tulsa, Oklahoma 74101 USA

Reppert SM, Gegear RJ, Merlin C (2010) "Navigational mechanism of migrating monarch butterflies", *Trends in Neurosciences*, 33, 9: 399-406

Stephen Malcolm and Myron Zalucky (2011) Biology and Conservation of Monarch Butterfly, Science Series No 38, Natural History Museum of Los Angeles County, California