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Underground electromagnetic activity in two regions with contrasting seismicity: a case study from the Eastern Alps and Bohemian Massif

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Electromagnetic emissions (EME) occur during the fracturing of solid materials under laboratory conditions and may represent potential earthquake precursors. We recorded EME from May 2015 to October 2015 in two caves situated in contrasting seismotectonic settings. Zbrašov Aragonite Caves are located close to the seismically quiescent contact between the Bohemian Massif and the Outer Western Carpathians while Obir Caves are located near the seismically active Periadriatic Fault on the southern margin of the Eastern Alps. The specific monitoring points are located at depths of tens of metres below the ground surface as such places are assumed to represent favourably shielded environments. The EME signals were continuously monitored by two custom-made Emission Data Loggers (EDLOG), comprising both analogue and digital parts. The crucial analogue component within the EDLOG is a wideband shielded magnetic loop antenna. To be able to observe EME related rock deformation and microfracturing we recorded signals between 10 and 200 kHz with a sampling frequency of 500 kHz. An ultralow noise preamplifier placed close to the antenna increases the signal-to-noise ratio. Further signal processing consisted of filtering, such as antialiasing and interference rejection, and additional amplification to fit the signal to the full scale range of the AD convertor. The digital part of the EDLOG comprises a range of PC components such as high-capacity replaceable data storage and unbuffered RAM, high-speed multichannel DAQ cards, and custom made control software in the programming environment LabVIEW. During our EME monitoring all the raw data were stored. This has allowed us to perform advanced data processing and detailed analysis. During the study period some artificial EME signals were observed in Zbrašov Aragonite Caves. This artificial noise may have overprinted any natural signals and is most likely to relate to the pumping of CO_2. In contrast, markedly different signals were observed in Obir Caves. From May to the end of July the data were characterised by a series of irregular high energy anomalies, lasting from hours to days, along with a series of regular nightly anomalies which are thought to relate to the VLF transmitters. From the beginning of August to October the data were characterised (except for the artificial nightly signals) by relative quiescence of other signals with only a few distinct anomalies. Data relating to rock deformation along active tectonic faults is also recorded at Zbrašov Aragonite Caves and Obir Caves using a type of automated moiré extensometer called a TM-71. These data have been interrogated alongside other environmental factors such as seismicity, precipitation, earth tides, and extraterrestrial magnetic radiation (all data provided by the Central Institution for Meteorology and Geodynamics (ZAMG)). It has been possible to compare all the phenomena with our data of natural electromagnetic activity. This pilot study was supported by the Institute of Physics at the Brno University of Technology, the Institute of Rock Structure & Mechanics CAS, and the Austrian Science Foundation (Project P25884-N29 “Active tectonics and recent dynamics of microdisplacements along major fault systems of the Eastern Alps registered in caves (SPELEOTECT)”.