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Development and implementation of a low-cost long-period telluric recorder for deep Earth electrical investigations

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Magnetotelluric loggers are key instruments for deep geophysical studies of crust and mantle. However, conducting a large-scale survey requires the implementation of a series of magnetotelluric instruments to complete the measurements in an efficient time. The main efforts and costs of a magnetotelluric survey are devoted to magnetic recordings. Therefore, using a compination of magnetotelluric stations along with parallel tellurics recorders can significantly reduce the time and costs needed to complete a regional survey. Based on this motivation, we present the construction, implementation and case studies of a long period telluric recorder (LPTR). The telluric recorder is based on a 24 bit ADC with a multiplexer that enables 2 differential channels devoted to the Ex and Ey telluric components. The multiplexer is adjusted to provide 1sample per second from each channel that corresponds to 2Hz sampling rate at the ADC. The multiplexing at this rate reduces the ADC efficient resolution to 20 bit. As the full measuring range is +/- 1.25V the least significant bit LSB is about 2.4 micro V. The output of the ADC is transferred via USB to a mini PC for time stamping and saving. The time of each record is provided from a GPS with accuracy of 1 ms. The LPTR is connected to the ground using a Cu-$CuSo_4$ nonpolarizable electrodes. The electrodes are specially constructed to provide good and longterm connection to the ground in arid environments. The LPTR has been tested throughout several field implementations in Egypt. The setup for contiuous telluric acquisition is realized in Moghra, Dakhla, Farafra and in Fayoum. These locations covers a variety of northern and southern Egypt as well as western desert and Nile valy. During the test implementations the recorder is put to run parallel to an ADU07-e magnetotelluric system for 1-3 days then for 2-4 months to be compared and integrated with the magnetic observatories at Fayoum and Abo Simble. Both observatories are running MAGSON fluxgate magnetometers at a sampling rate of 1 Hz. The resultant data showed that the LPTR synchronizes with the ADU07-e at periods from 5s and with the magnetic observatory data at periods 25s. This indicates an efficient low-cost system that can be used for deep Earth resistivity investigations. A case study of 2-4 months of continuous telluric recordings that have been processed with magnetic observatories data provided impedances for periods up

to 42000 seconds. The results are 1D modeled for depths of more than 800KM. A comparison between the obtained 1D MT model and global Earth-models (LITHO1) based on seismological data shows a quite good matching at the deep interfaces like upper crust, middle crust and lower crust. The delineation of seismic discontinuities at 410 KM and 680 KM shows corresponding clear change in resistivity at 410 KM and then at 700 KM as well.