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Reigate Caves, UK: a historic sand mine system – real-time radon concentration survey results and time-averaged SSNTDs.

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The caves in Reigate are situated along Tunnel Road. Their history is somewhat uncertain but they have been used in the recent past as air raid shelters, wine stores, a cold-war bunker etc. They consist of an East and West system separated by a road now used for foot traffic only, and a much older cave called Barons cave which is thought to have a medieval origin (11th Century AD) and has been associated with Reigate Castle. Little of the latter now remains.

The western caves were used as air raid shelters during the Second World War and now are home to a shooting range. Measurements for radon gas concentrations were made in this system as a series of snapshot real-time readings, but due to access difficulties the bulk of this project work was undertaken in the eastern caves.

The latter were measured over a 9 month period for radon gas using a Rad7 real-time radon detector taking 2 hourly readings. The data for each 3 months was downloaded at Kingston University and the detector replaced. Alongside the Rad7 CR39 based SSNTDs were placed throughout the eastern cave system to ascertain the overall pattern of radon distribution and compare results with the real-time detector. The latter was placed in the centre of the cave system for the first 6 months, but was moved to an abandoned wine cellar for the last 3 months due to power supply issues. When visits were made to change the desiccation tower used for the Rad7, measurements were also made on occasion using a Sarad Doseman real-time dose monitor. The Rad7 results showed considerable radon variation with a maximum of 640 $\pm$ 44 Bqm-3 being noted in the summer months (August 2010), highs in June and July of 417 $\pm$ 35 Bqm-3 and 479 $\pm$ 38 Bqm-3 respectively, and highs in the winter period of around 239 $\pm$ 27 Bqm-3and 341 $\pm$ 32 Bqm-3. The winter and spring periods showed lower averaged results than the summer period. This is in an area identified by the Health Protection Agency where 1-3% of homes are above the UK indoor radon Action Level of 200 Bq m-3 (Miles et al., 2007).

The eastern caves extend the length of Tunnel Road and meet up with the back of a café partly built into the hillside (Café Rouge) which has an abandoned wine cellar within the cave system. They are overall at a slightly shallower depth than the western caves. These caves were divided into 2 at one stage, with an air-raid shelter for Town Hall staff, and a standby Bomb Report Centre set up by the ARP (Air Raid Precautions) system. This report centre contained sleeping quarters, document storage, a canteen and a gas decontamination area. The rooms were also to be used as a Police and Fire Brigade HQ and a First Aid post.

These sand mines (not naturally formed caves in the true sense although called caves locally) are thought to have a Victorian origin and were used to extract sand for glass blowing. The white marine shallow-water deposited (Richards and Barton, 1999) silica sands of the Lower Greensand Group, Folkestone Formation (the Formation outcropping as a band between 0.5 and 1.5 miles wide from the Kent border to the west of Guildford, broadening to the south of Farnham) here contain very little in the way of cement holding grains together (with a typical porosity in the area of around 30%; Cresswell and Barton, 2003), and under the microscope can be seen to contain mostly angular to sub-angular quartz fragments, some of which show undulose extinction under cross-polarised light microscopy. This suggests a metamorphic origin for the quartz. There are also some relatively rare rock fragments present. The sands are what are known as locking sands in that due to the grains having re-entrant angles they lock together under compression (having both tensile and compressive strength), so can support the buildings built on them (Richards and Barton, 1999). These silver sands are a mixture of fine to medium grain sizes (0.10 to 0.5 mm) with small proportions of finer and coarser grades (up to 12% course silt in

the caverns at Reigate Castle) and are in the order of 30 - 36 metres thick (Gossling, 1929). The sands are known to contain very low levels of iron oxide and alumina, although in the eastern caves one can see fault / fracture lines, some at very shallow angles, where iron oxide has accumulated. One can also see iron oxide banding in places that may represent past groundwater levels. These beds then show both lateral and vertical variability.

Samples have been taken of the sands for ICPMS analysis to ascertain their geochemical composition. One reason for doing this is to see if there is a source for radon gas within the sands (whether in other words any gas present in the cave system is supported or unsupported).
The Wealden Cave and Mine Society conduct public tours around these caves from time to time. A tour of the western caves takes about 30 minutes whilst a tour of the eastern system takes around an hour. Private tours for Schools etc are also organised down these caves on an irregular basis.

Results of our survey suggest that considerable variations in radon gas concentrations occur through both daily and greater length cycles. Analysis is under way to see whether these cycles related to cave occupancy – steel doors to the caves being opened and closed for access introducing fresher air into the system for example – or to cycles associated with weather patterns, tidal variations etc.

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