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On ice and snow deposits in caves and their suitability to paleoenvironmental research

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The “ideal deposit” to be investigated as an archive of proxy climate information should exhibit a good accumulation rate trade-off between the contrasting requirements for high time resolution and long time coverage; it should be possible to find vertically continuous and essentially undisturbed stratigraphic columns; discontinuities, strain and other such stratigraphic and structural features should be easily detectable and accounted for; finally, the investigated material should offer the possibility to apply established dating methods and, whatever parameter we are analysing, we should be able to correlate our results with those available from the local, regional or global environment. Of course, a further desirable feature is for the genetic processes to still be active and directly observable, somewhere.

Actually, this “wish list” is not at all exclusive of the Cryospheric Sciences, being shared with large parts of the Earth and Environmental Sciences. Nevertheless, deep ice coring projects are showing that high latitudes ice caps are meeting those requirements to a particularly good extent.

Ice caves (karstic or volcanic caves hosting perennial ice deposits) represent a little known, generally neglected environment that in the very last years is receiving a remarkably fast-growing scientific attention. The occurrence of ice caves is not uncommon in many mountain areas at mid-latitudes and under favourable conditions they

can be found even at altitudes lower than 1000 m a.s.l. (e.g. the Dobšinská ice cave in Slovakia). In Europe, they are a very common feature of the high mountain karst in the Alps, but they are present from Sicily (Grotta del Gelo, Etna) to Spain, from the Carpathians (Gheţarul de la Scărişoara, Romania) to the Urals (Kungur ice cave, Russia) to the Caucasus. Large, stratified ice deposits are found in several ice caves and this ice blocks pose a challenge as to the determination of their age, origin and evolution. Sometimes, the very meaning of the ice layering is still an open problem. While most probably lacking some desirable features (mainly in terms of continuity and long time coverage) many large cave ice deposits possess the distinctive advantage of residing in the well sheltered, highly stable cave environment. Furthermore, because of their geographic location near to densely populated and industrialized areas, we could expect to obtain highly sensitivity records of the man-induced changes in the local environment. The first written reports and observations about ice in caves dates back at least to Leonardo da Vinci, and long (several decades) systematic record of topoclimatic data are available for some European ice caves, but only a handful of other research is to be found in the published literature until very recent times. Quite suddenly, this situation is going to develop: the papers contributed to the 1^{st} International Workshop on Ice Caves (IWIC-I) held in Romania in March 2004 showed that many new researches are active, ranging from studies on stable and radioactive isotopes, ice crystal fabric and chemical composition of the ice to analyses of the palinologic and insoluble particles content, from physical modelling to applications in the conservation of ice blocks in show caves opened to tourists(1).

Building on the aforementioned concepts and summarizing the results from ongoing field work and cave ice coring in the Central Italian Alps and in the Romanian Carpathians, from laboratory analyses and from selected literature we try to evaluate the suitability of several types of hypogean ice and snow deposits to serve as a viable archive of proxy climate information.

(1) Citterio M. & Turri S. (eds.) 2004 - Volume of Abstracts of the 1^{st} International Workshop on Ice Caves (IWIC-I), Căpuş, Romania, 1^{st}-3^{rd} March 2004, p. 28.