MINERALOGICAL DATA CONCERNING MOONMILK SPELEOTHEMS IN FEW CAVES FROM NORTHERN NORWAY

MINERALOŠKI PODATKI O KAPNIKIH IZ JAMSKEGA MLEKA V JAMAH SEVERNE NORVEŠKE

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Bogdan P. Onac: Mineraloški podatki o kapnikih iz jamskega mleka v jamah severne Norveške

Prispevek predstavlja mineraloške raziskave nekaj vzorcev kapnikov iz jamskega mleka, nabranih v nekaterih jamah severne Norveške in razlago njihovega izvora. Različna morfologija kristalnih oblik je bila določena z vrstičnim elektronskim mikroskopom, difraktogrami x-žarkov pa predstavljajo glavni način analize jamskega mleka.

Ključne besede: speleologija, jamski sedimenti, mineralogija, jamsko mleko, kristalografija, Norveška

Abstract UDC 552.55:551.44(481)
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Bogdan P. Onac: Mineralogical data concerning moonmilk speleothems in few caves from northern Norway

The paper presents some mineralogical investigations on some moonmilk speleothems sampled in few caves from north of Norway, as well as some considerations concerning their origin. Different morphological crystal shapes are characterized through scanning electron microscope analysis. The X-ray diffractogramms results are also presented being the main way to analyse the mineralogical composition of the moon- milk.

Key words: speleology, cave sediments, mineralogy, moonmilk, cristalography, Norway

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GENERAL DATA

Very little has been written about the mineralogy of moon-milk from Norwegian caves. As a matter of fact the very first step was done by Horn (1937) who sampled a "soft white mud" from a cave called "Tukthuset". These samples were analysed from micro-biological point of view a few years later by Hoeg (1946).

Sporadically informations on this topic are published in periodicals such as Studies in Speleology (e.g. S. St.Pierre,1967) and Norsk Grotteblad. Two recent papers (Onac, and Farcas, 1992) and (Onac, and Lauritzen, in press) contain a mineralogical approach to the moonmilk deposits of some Norwegian caves.

The present paper aims to offer some mineralogical results on moonmilk speleothems sampled from fifteen different caves, all situated beyond the Arctic Circle, as well as several considerations concerning their origin. Given the anthropogenic "contribution" to environmental change in caves we will avoid specifying the location of those in which important moonmilk speleothems have been observed.

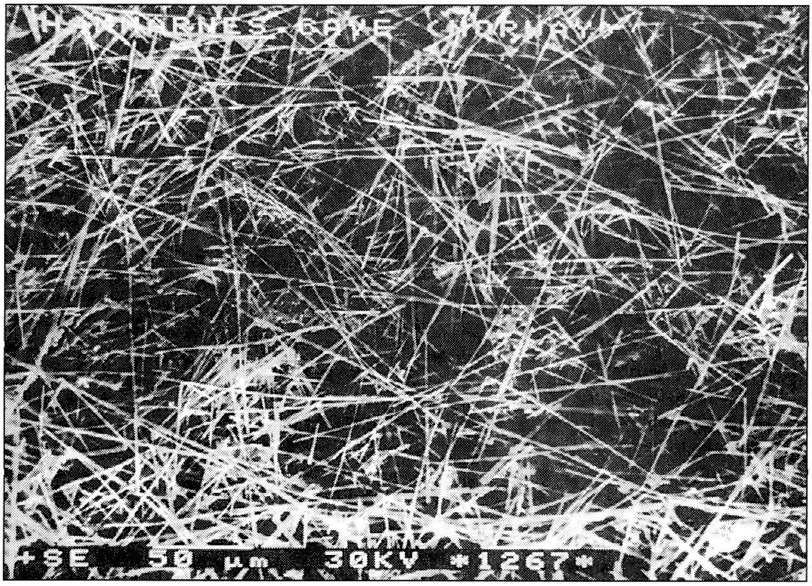
FIELD OBSERVATIONS

As we have mentioned above, all sampled caves are located beyond the Arctic Circle, being developed in methamorphosed calcite and dolomite marbles. These have suffered extensive recrystallizations and tectonic folding during the Caledonian orogenesis (**Lauritzen, 1991**).

Developed under certain circumstances such as the cold climate with precipitations which rise above 1000 mm/yr (snow and rain) and the petrography of the karstifiable areas, the entire karst of northern Norway has several peculiarities. We will dwell just with the endokarst, looking upon those caves which provided moonmilk samples for our study.

Such being the case we can say that most of the caves visited are active vadose streamways, just a few being completly dry (without underground stream). We sampled moonmilk from both categories.

The measured temperatures around the sampled points was between 4.5°C and 8.0°C, relative humidity being 100%.



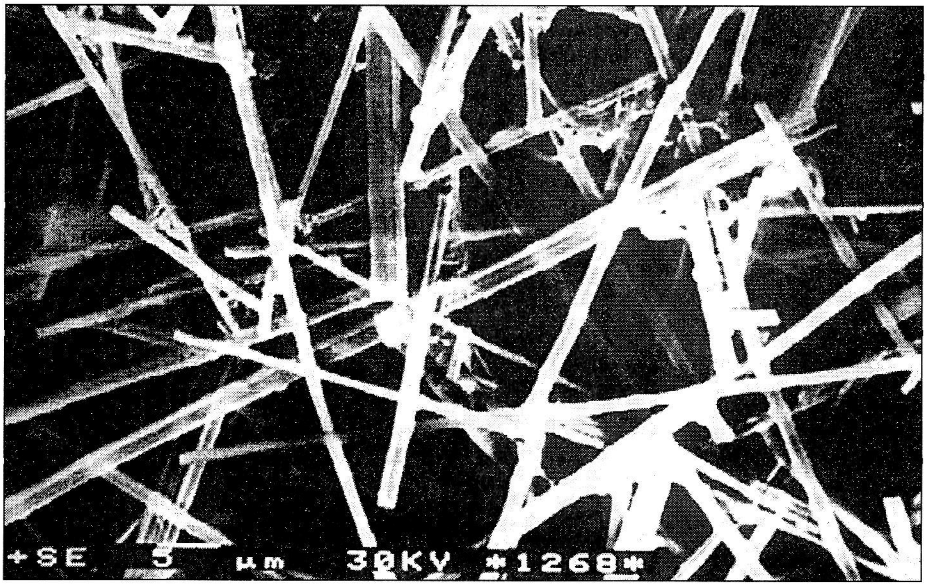


Fig. 1 - Threadshaped calcite crystals (SEM)

ANALYSIS RESULTS

Moonmilk often occurs as a white, sometimes whitish-yellow pasty coating covering cave walls (the thickness varies between a few mm. up to 15-20 cm.) or other speleothems. It can also form as cauliflower-like flowstone, stalactites, draperies, and even small pools. All temperatures we measured inside the sampled mooonmilk were under 5°C. When wet it is soft and plastic, but when dry it is white powdery material.

Water absorbtion capacity was calculated on 5 different samples using the following formula: (Ww-Wd)*(Ww) *100(%). Ww and Wd represent wet respectively dry sample weight. The values we obtained are: sample 1 (S1)=58%, S2=91%, S3=88%, S4=90%, S5=68%.

X-ray Analysis

Using a Phillips X-ray diffractometer, our analysis detected the presence of the calcite in more than 70% of our moonmilk samples. At the same time, hydromagnesite or gypsum and calcite have been identified. Typical lines for monohydrocalcite are also to be found, being quite normal, as this cave mineral has been reported as a cold water deposit in a fine mist environment (**Hill, and Forti, 1986**).

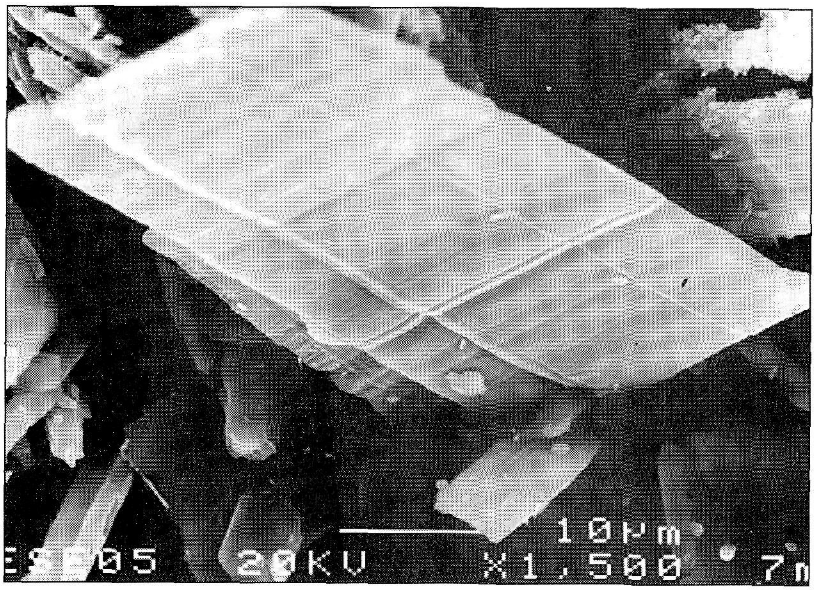


Fig. 2 - Striated (010) gypsum crystal (SEM)

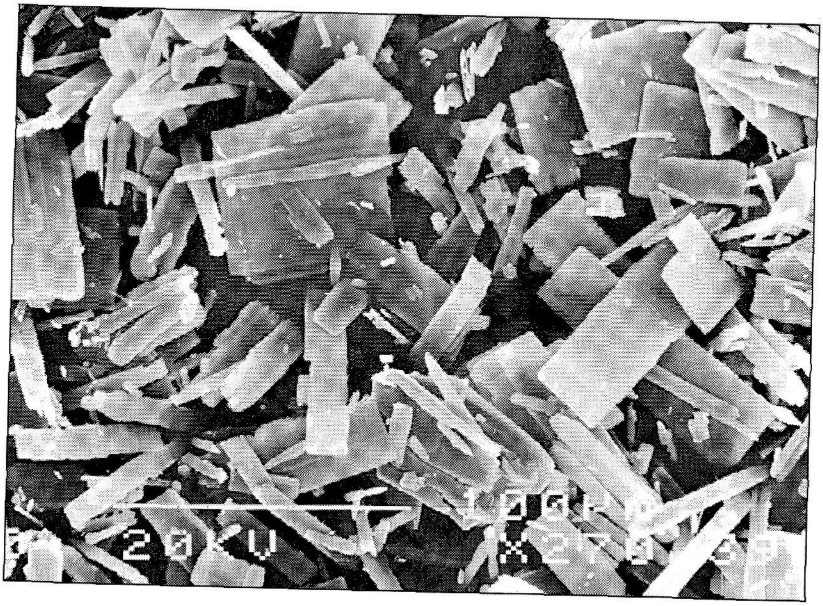


Fig. 3 - Lamellar gypsum crystals (SEM)

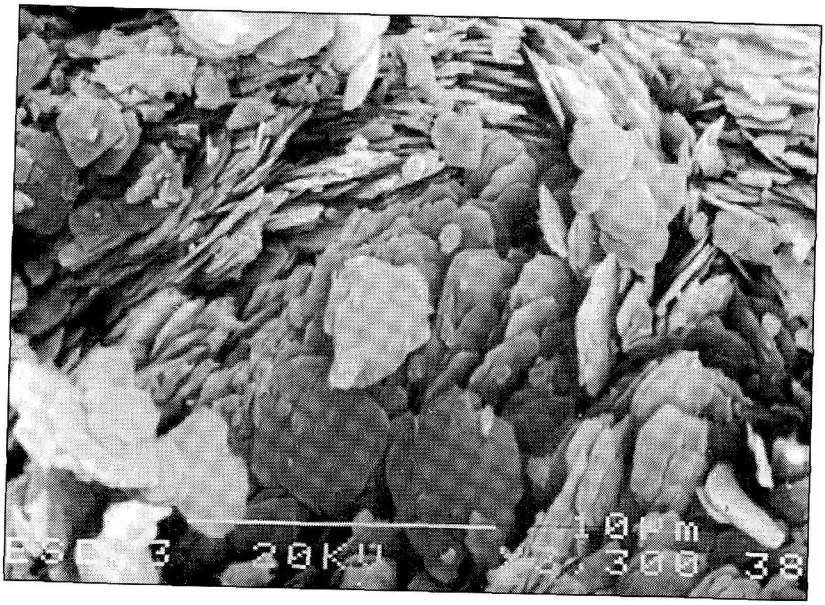


Fig. 4 - Plate like lamellae of gydromagnesite (SEM)

SEM Analysis

The crystalline phase of calcitic moonmilk as it is shown on the scanning electron microscope consists of threadshaped calcite crystals (**Bernasconi,1975**), having almost similar sizes (**Fig.1**); the surfaces of the crystals are covered with colloidal clayey particles which are probably responsible for the ability of the moon-milk to retain such an impressive amount of water. Some of these threadshaped calcite crystals are in fact pseudomorphs of calcite after monohydrocalcite.

In the moonmilk sample which had provided, through X-ray analysis, the presence of gypsum and calcite we identified threadshaped calcite crystals in association with specific striated (**010**) faces gypsum (**Fig. 2**). Lamellar gypsum crystals are also very common in the structure of the moonmilk (**Fig. 3**) we sampled from one of the caves.

Microscopic thin plate-like lamellae (**100**) of hydromagnesite (**Fig. 4**) were identified in only one moonmilk sample, collected from behind a gypsum "balloons" (**Onac, and Lauritzen**, in press).

DISCUSSION AND CONCLUSIONS

The direct precipitation from ground water is dependent on its degree of saturation, temperature and the pressure on which the deposition take place. The "punctiform" presence of the moonmilk speleothems along cave galleries could support this statement.

All components of the crystalline phase of calcitic moonmilk are formed from more or less calcium rich natural waters in intimate contact with the cave atmosphere, in which the pH of the system is controlled entirely by the carbonate equilibria. If there are rootlets in the soil through which the percolating water passes, or other sources of CO_2, there will be a corresponding increase in calcite solubility and a lowering of the equilibrium pH.

We believe that carbonate equilibrium from "mother" solution as well as its temperature, and passage ventilation have a major influence in the deposition of moonmilk.

If it is the nature of hydromagnesite to form as finely-microcrystalline or cryptocrystalline moonmilk deposits (**Hill, and Forti, 1986**) the crystalline phase of calcitic moonmilk can exhibit (**Bernasconi, 1975**) much more microcrystalline forms (thread, lamellar, prismatic etc.). Their genesis can be assigned to the above mentioned conditons as well as to the thermodynamics of crystals growing (**Onac, in prep.**).

Owing to several cross sections made in some moonmilk speleothems we found 2 or 3, sometimes 4 different types of moonmilk layers. Close to bedrock it is almost dry, getting more and more wet in the outermost part of the deposit, corresponding to a depositional sequence from monohydrocalcite to calcite. This observation might prove **Fischer's (1987)** suggestion concerning the moonmilk genesis. In time, when seeping water supply decreases or disappears the whole moonmilk deposit becomes dry, building up a porous calcite crust.

In our opinion all the moonmilk speleothems we examined have a primary origin (**Diaconu, 1976**) precipitating directly from ground water as do other many speleothems.

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Povzetek

V prispevku so predstavljeni izsledki mineraloških raziskav kapnikov iz jamskega mleka, nabranih v jamah na severnem Norveškem, onkraj polarnega kroga, v metamorfoziranih kalcitih in dolomitnih marmorjih. Vse jame so aktivne vodne jame. Vsi vzorci jamskega mleka so imeli temperaturo pod 5^{0}C, zmožnost absorpcije vode pa je znašala med 58 - 91 %. Analize z x - žarki so pokazale prisotnost kalcita, monohidrokalcita, hidromagnezita in sadre. Kalcitno jamsko mleko se pod vrstičnim mikroskopom pokaže kot igličasti kristali, pokriti s koloidnimi delci gline, sadra pa v obliki lamel.

Avtor meni, da so ravnotežje karbonatov v "matični" raztopini, njena temperatura in prezračenost rovov, najpomembnejši dejavniki za odlaganje jamskega mleka. Sklepa tudi, da so preiskani kapniki iz jamskega mleka prvotnega nastanka, kar pomeni, da se je jamsko mleko precipitiralo neposredno iz podzemeljske vode.