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# book reviews

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**The mystery of the giant crystals**. A film directed by Javier Trueba. Written and presented by Juan Manual García Ruiz. Madrid Scientific Films, 2010. Cat No. HR5-208. Duration 110 min. Format: HD (16:9). Available on DVD and Blu-Ray. Price USD 18.

The subject of this film is the presentation of fascinating pictures of natural giant gypsum (selenite) crystals found in four deposits in Spain, Mexico and Chile. The film, produced in 2010, was certainly stimulated by the discovery of the 'Cueva de los Cristales' ('Crystals Cave') in the Naica mine, Chihuahua, Northern Mexico. The world's biggest gypsum crystals, with dimensions up to 2 m in diameter and 11 m in length, were found inside that cave.

The documentary is available in three languages (Spanish, French, English), with subtitles in English, French, German, Japanese and Spanish, and is accompanied by background music. Professor Juan Manual García Ruiz, from the Laboratory for Crystallographic Studies of the University of Granada, is the director and presenter of the film and guides the viewer through the documentary with historic and scientific comments and background information. The film begins with a historic review of the ruins of Segóbriga in Spain. In the first century, Segóbriga was a wealthy Roman city based on the mining of large selenite crystals (lapis specularis). The large size of the crystals, their high transparency and their perfect cleavage along the (010) plane made them suitable for use as window glass for Roman palaces. However, towards the end of the first century, the deposit at Segóbriga lost its importance because the Romans were able to produce glass in a different way. At the end of the first chapter of the film, a short computer-animated comparison between the crystalline and amorphous solid states is presented in a popular scientific way.

Prompted by the question 'Are there larger gypsum crystals?', the next scene focuses on the giant gypsum geode in Pulpí, Almería, also in Spain. This geode, with an inner length of 8 m and a width of 1.8 m, was discovered in 1999 in an old lead and zinc mine. The crystals display a very high transparency with only a few inclusions and have dimensions on the centimetre to metre scale. A simple laboratory experiment then shows the conditions that determine crystal size in growth from an aqueous solution. Salt solutions (unspecified in the film) are heated and saturated, and then cooled to room temperature in glass beakers with and without thermal insulation. Naturally, larger crystals are grown in the case of the reduced growth velocity inside the thermally insulated beaker. The film then continues to show minerals and gives an introduction to the history of the Naica mine in Mexico. Next to the lead and zinc ore mine, the so-called 'Cave of Swords' was detected in 1910 at a depth of 120 m. It contains smaller gypsym crystals on the centimetre scale. The smaller the dimensions of the crystals, the higher their number. Therefore, the question arises as to which growth parameters determine the dimensions of the crystals. Another deposit that contains giant gypsum crystals is the 'El Teniente' mine in Chile. However, the main report on this location only discusses its history during the last century.

At this point, the second part of the documentary starts, providing more scientific background. Fascinating pictures of the 'Crystals Cave' in the Naica mine are shown. By reducing the ground-water level, this cave was discovered in April 2000 by drilling through the Naica fault at a depth of 290 m. The giant gypsum crystals are arranged like mikado sticks, with weights up to 25 t. For humans, a short stay of only about 8 min inside the cave is possible, owing to the high temperature of 50°C (323 K) and humidity of nearly 100%.

The important scientific part of this film is the discussion of the dimensions of the crystals and their growth conditions. A graphical presentation shows the geological formation of the Naica mine. Millions of years ago, a rising magma chamber with a temperature of about 1073 K stopped several hundred metres beneath the surface and provided ore material and heat. But how was it possible for the gypsum crystals to grow to such gigantic sizes? The film gives the answers to this interesting question. First, the investigation of liquid inclusions shows that the brine solution also contains calcium sulfate. From this, one can infer that the growth of the gypsum crystals was caused by a recrystallization of anhydrite in an aqueous solution at a temperature of about 323 K. The growth behaviour of gypsum planes is instructively demonstrated using a confocal microscope. With respect to the large size of the crystals, it is stated that the growth velocity of the giant gypsum crystals is estimated to be ~60 μm per century, meaning that extremely constant growth conditions existed over a period of about 500 000 years. Contrary to the given value, the growth rate is estimated by us to be in the range of several millimetres per century for crystal sizes of metre scaling.

The documentary serves as a suitable introduction to the world of minerals. Screen sequences of the world's biggest selenite crystals from many different places on Earth are featured. Apart from some historical aspects of the utilization of gypsum crystals, the film gives explanations of the growth conditions of crystals from aqueous solutions in a scientifically popular manner, including the estimation of the extremely low growth velocity of natural gypsum crystals. The film should be suitable for presentation on scientific TV programmes, as well as for an introduction to mineralogy or geosciences lectures at university level. Unfortunately, more detailed and scientific information on the complex relationship between the anhydrite and gypsum recrystallization processes is missing. Thus, the expectations of specialists in crystal growth may not be fulfilled.

**Manfred Mühlberg**
Institut für Kristallographie, Universität zu Köln, D-50939 Köln, Germany

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