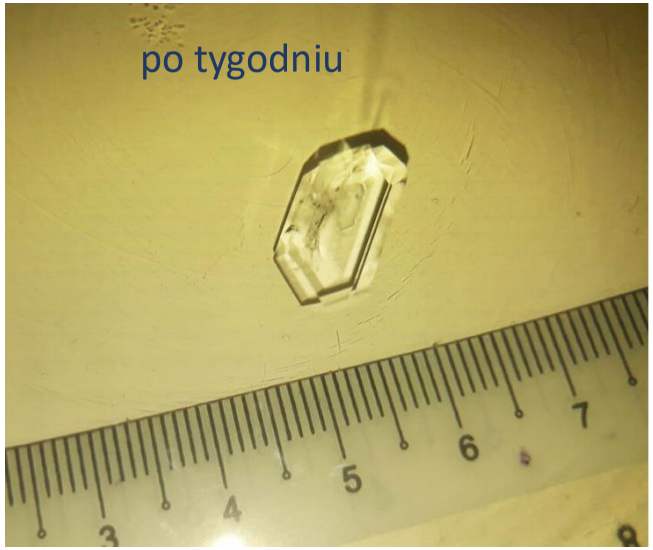
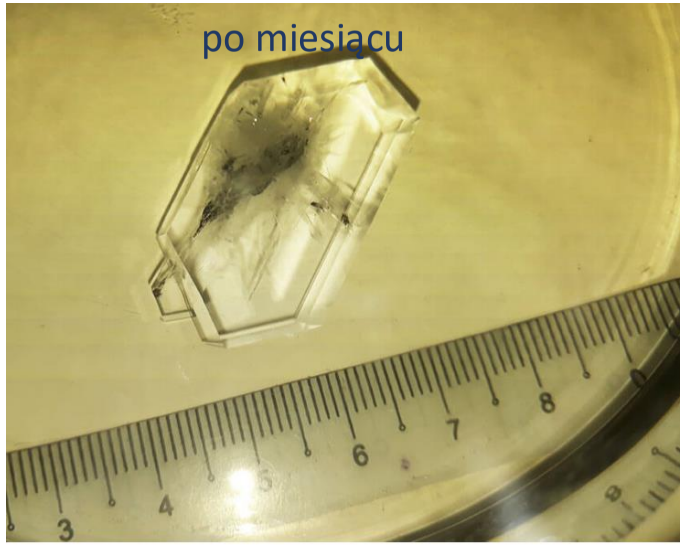
Wzrost kryształów

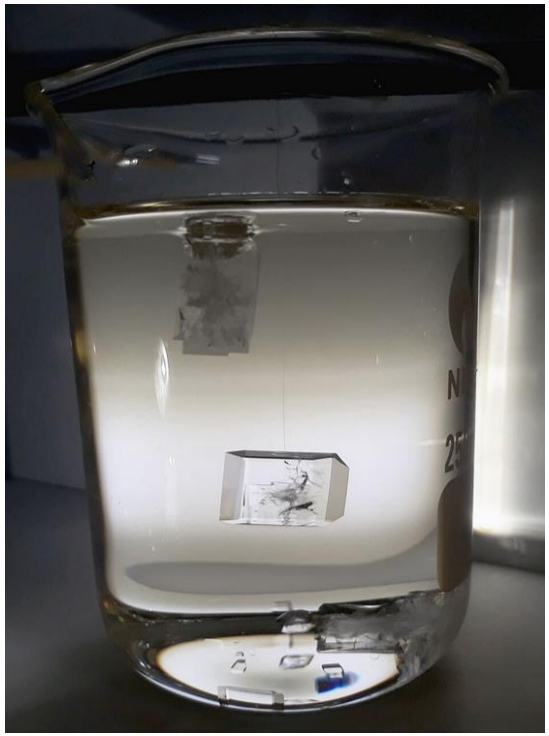
Polikryształy cukru

https://crystalverse.com/sugar-crystals/

Monokryształy cukru







https://crystalverse.com/sugar-crystals/

GEOCHEMISTRY

Naica's crystal cave captivates chemists

Giant gypsum crystals reveal their secrets

by ***Emma Hiolski, special to C&EN***

February 8, 2019 | A version of this story appeared in **Volume 97, Issue 6**

Credit: Javier Trueba/MSF/Science Source

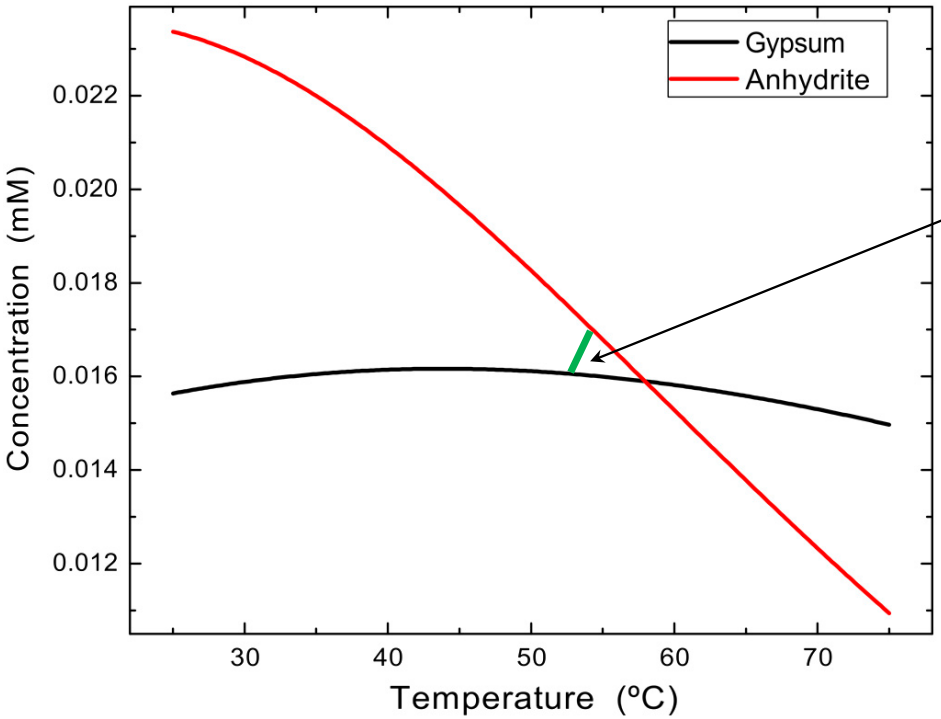
https://cen.acs.org/physical-chemistry/geochemistry/Naicas-crystal-cave-captivates-chemists/97/i6

🔥 The Cave of Crystals (La Cueva de Los Cristales) in Naica, Chihuahua, Mexico

Pobrano fragmenty kryształów gipsu

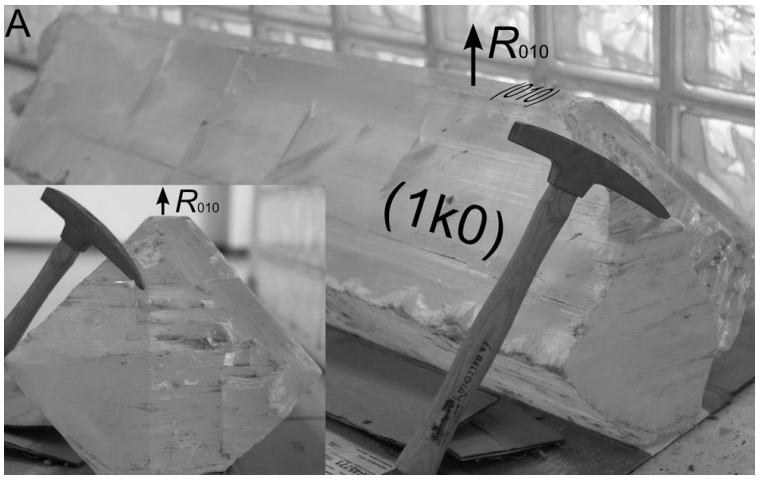
oraz

próbki roztworu obecnego w jaskini



Solubility curves of anhydrite (CaSO4) and gypsum (CaSO4:2H2O) as a function of temperature

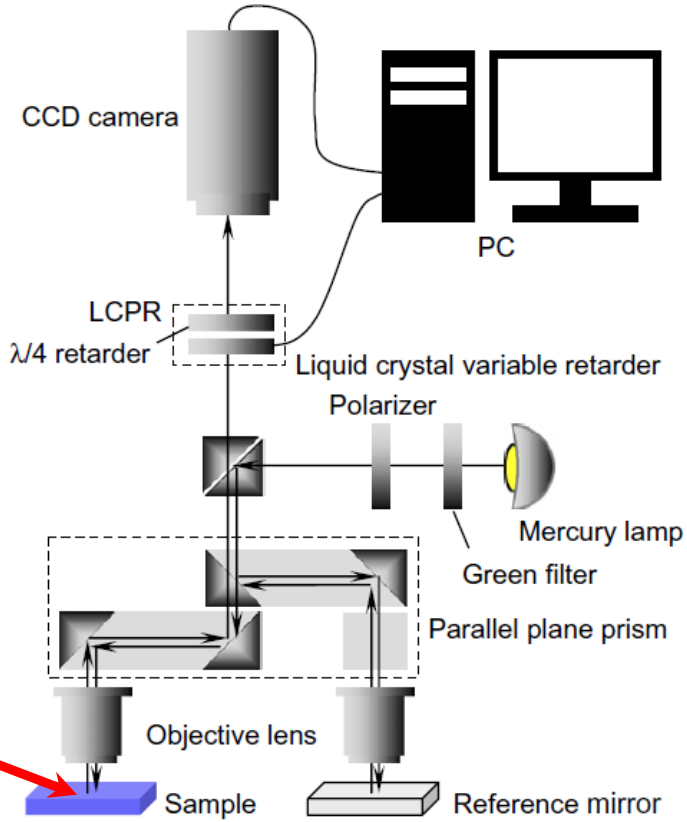
Obszar w przestrzeni parametrów w którym zachodzi wzrost kryształów gipsu w jaskini Naica



Ultraslow growth rates of giant gypsum crystals
A. E. S. Van Driessche, J. M. García-Ruíz, K. Tsukamoto, L. D. Patiño-Lopez, and H. Satoh
PNAS 108, 15721–15726 (2011).

www.pnas.org/cgi/doi/10.1073/pnas.1105233108

Eksperyment interferometryczny
pomiar położenia powierzchni kryształu



Kryształ
w swoim
roztworze

Fig. 1. Schematic diagram of the phase-shift interferometer. The overall apparatus consists of the interferometer, the monitor and the computer system, and is set in a clean room. The interferometer is located on an anti-vibration air table.

$$I_1(x,y) = I_0(x,y) \times [1 + \gamma_0(x,y)\cos\{\phi(x,y)\}], \quad (A.2)$$
$$I_2(x,y) = I_0(x,y) \times [1 + \gamma_0(x,y)\cos\{\phi(x,y) + \pi/2\}], \quad (A.3)$$
$$I_3(x,y) = I_0(x,y) \times [1 + \gamma_0(x,y)\cos\{\phi(x,y) + \pi\}], \quad (A.4)$$
$$I_4(x,y) = I_0(x,y) \times [1 + \gamma_0(x,y)\cos\{\phi(x,y) + 3\pi/2\}]. \quad (A.5)$$

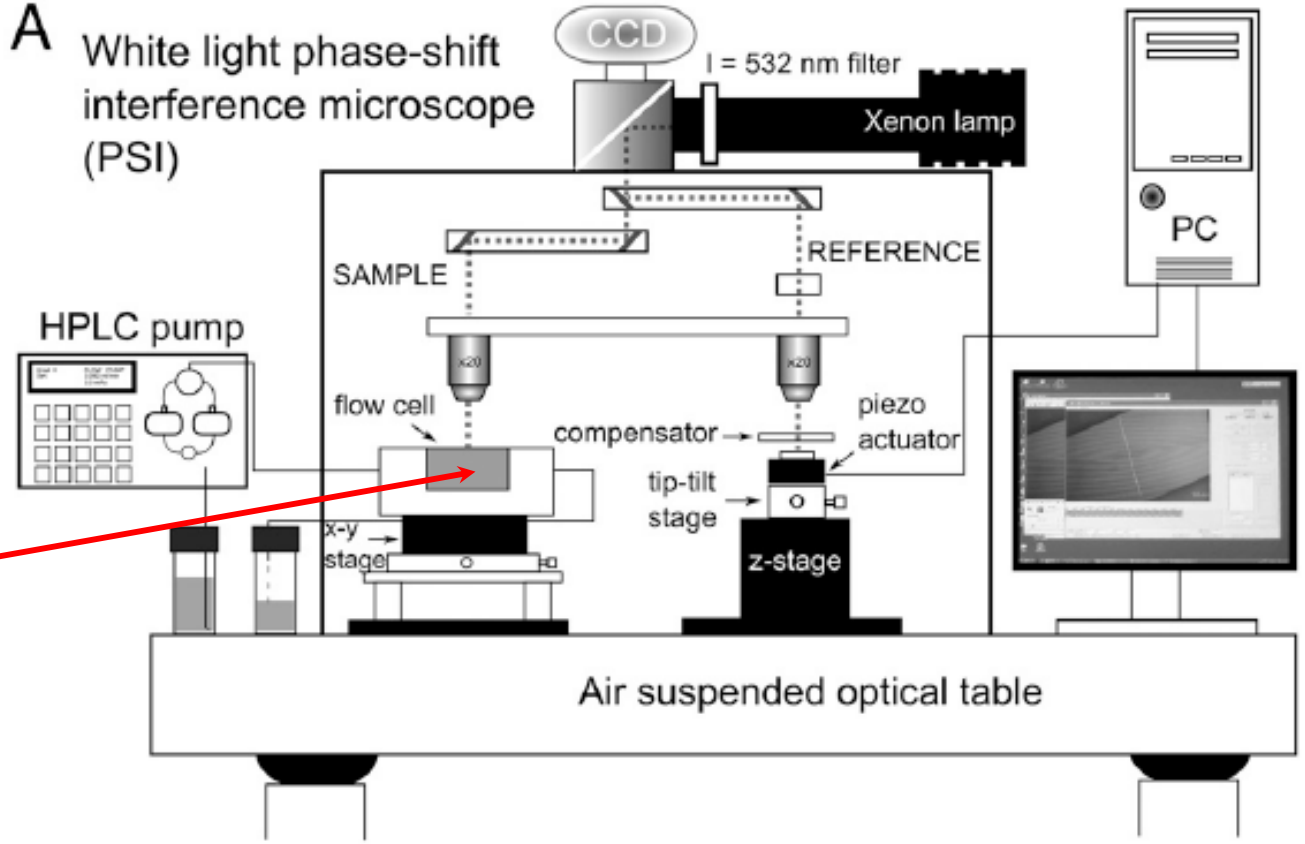
Here, if it is assumed that neither $I_0(x,y)$, $\gamma_0(x,y)$, nor $\phi(x,y)$ is changed within the time whereas 4 interference images are obtained, $\phi(x,y)$ is calculated by modifying Eqs. (A.2)–(A.5):

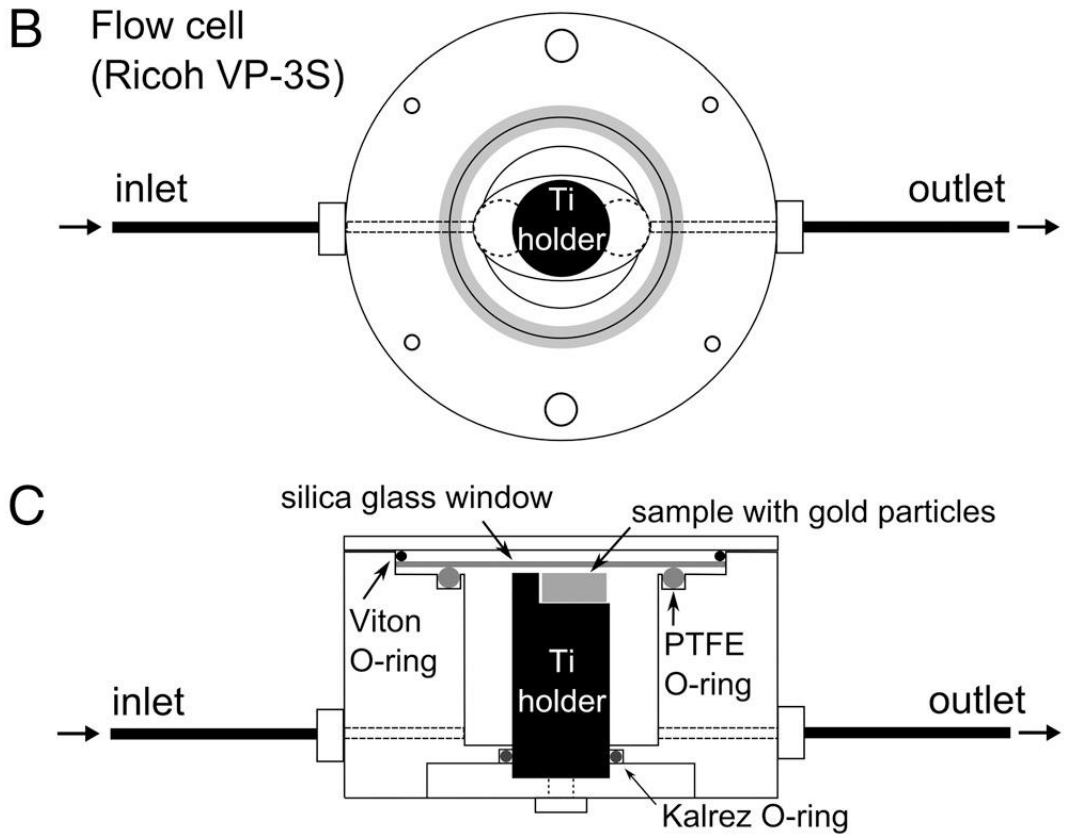
$$\phi(x,y) = \tan^{-1}\left(\frac{I_4 - I_2}{I_1 - I_3}\right). \quad (A.6)$$

Eq. (A.6) indicates that PSI can calculate $\phi(x,y)$ merely from intensities of interference fringe images. The height distribution over the sample surface, $\Delta h(x,y)$, is obtained based on this phase information:

$$\Delta h(x,y) = \phi(x,y) \times \frac{\lambda}{4\pi n}, \quad (A.7)$$

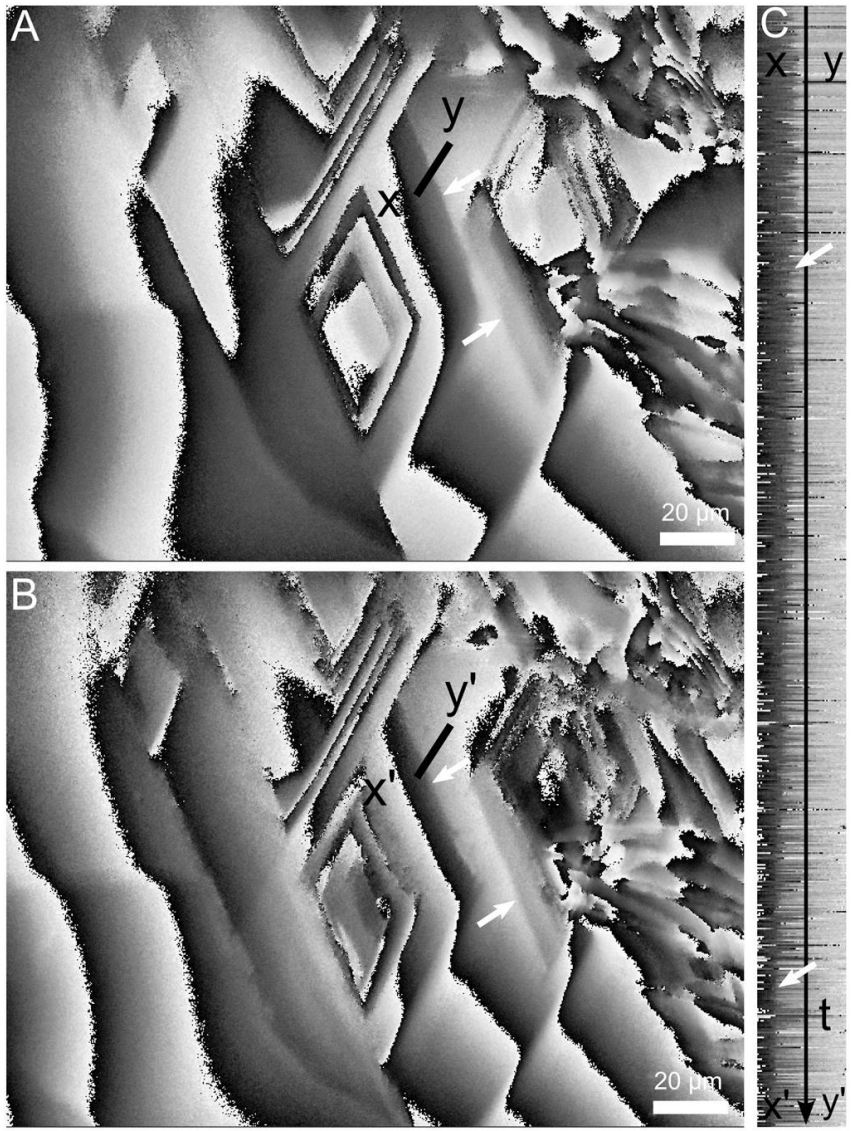
Próbka, tj. komórka
z roztworem i
kryształem
w kontrolowanych
warunkach, p, T





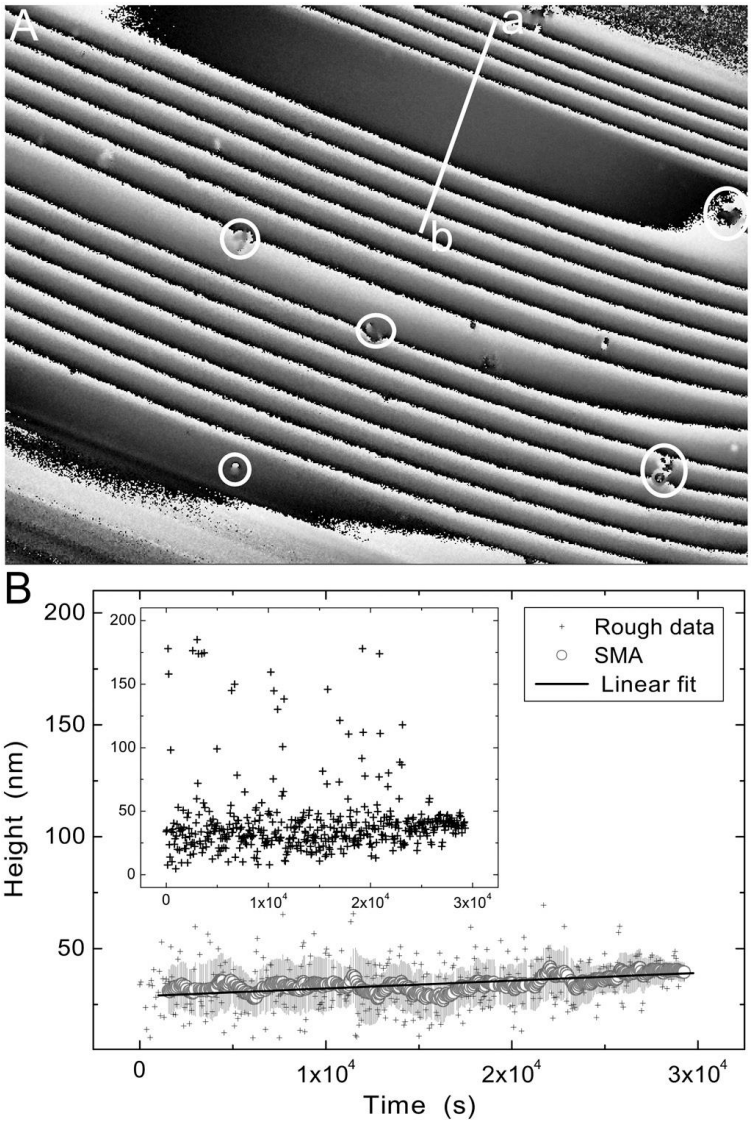
Temperatura w zakresie
40°C – 60°C

Ciśnienie 8 atm.



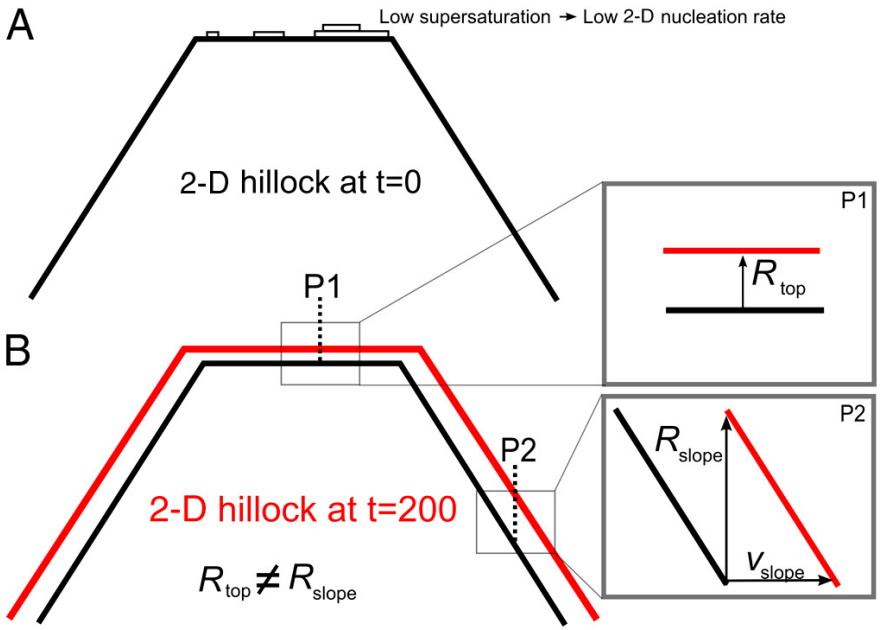
Ultraslow growth rates of giant gypsum crystals
A. E. S. Van Driessche, J. M. García-Ruíz, K. Tsukamoto, L. D. Patiño-Lopez, and H. Satoh
PNAS 108, 15721–15726 (2011).

www.pnas.org/cgi/doi/10.1073/pnas.1105233108



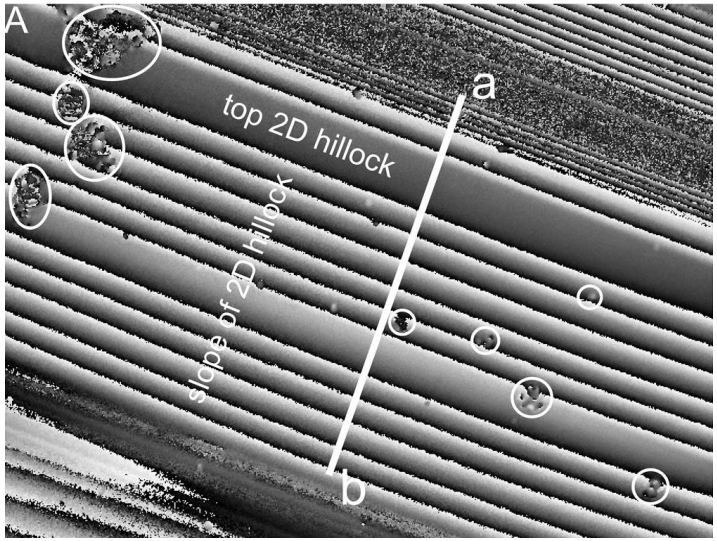
Ultraslow growth rates of giant gypsum crystals
A. E. S. Van Driessche, J. M. García-Ruíz, K. Tsukamoto, L. D. Patiño-Lopez, and H. Satoh
PNAS 108, 15721–15726 (2011).

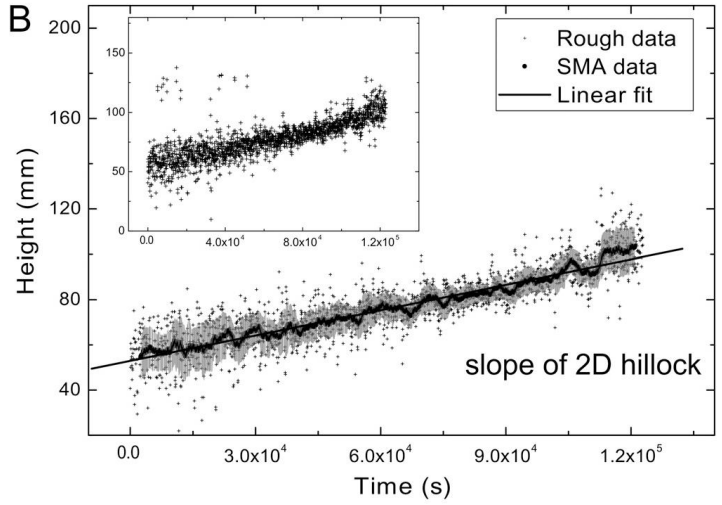
www.pnas.org/cgi/doi/10.1073/pnas.1105233108

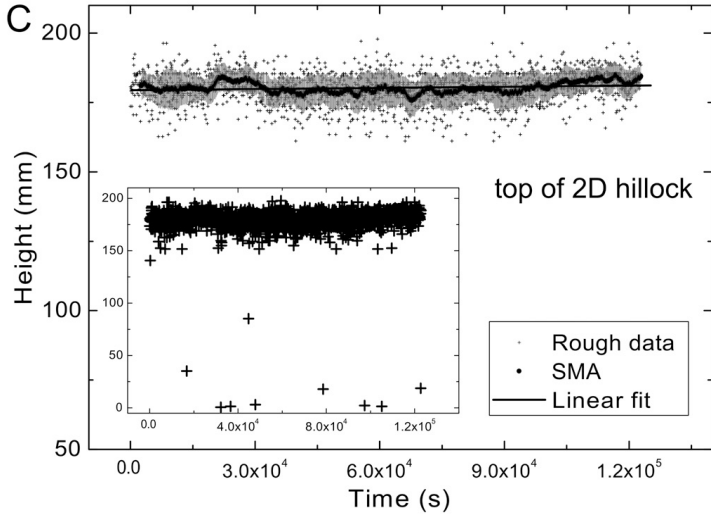


Ultraslow growth rates of giant gypsum crystals
A. E. S. Van Driessche, J. M. García-Ruíz, K. Tsukamoto, L. D. Patiño-Lopez, and H. Satoh
PNAS 108, 15721–15726 (2011).

www.pnas.org/cgi/doi/10.1073/pnas.1105233108



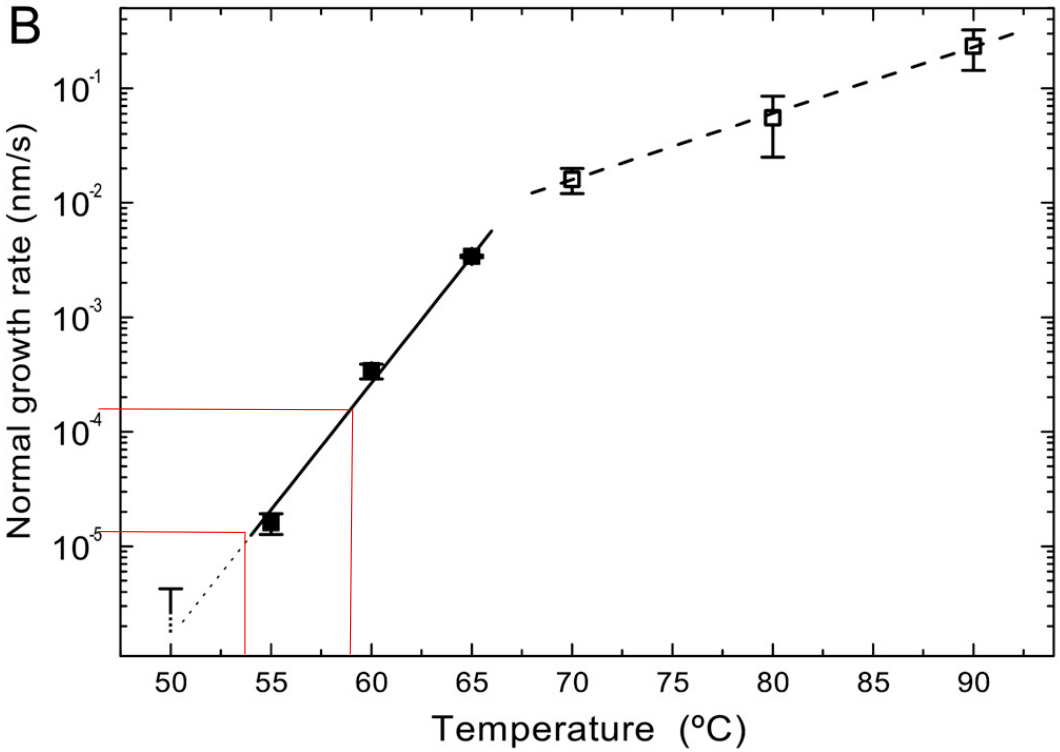




Ultraslow growth rates of giant gypsum crystals
A. E. S. Van Driessche, J. M. García-Ruíz, K. Tsukamoto, L. D. Patiño-Lopez, and H. Satoh
PNAS 108, 15721–15726 (2011).

www.pnas.org/cgi/doi/10.1073/pnas.1105233108

Prędkość wzrostu kryształów gipsu w funkcji temperatury



Wniosek:

Duże kryształy obecne w jaskini potrzebowały od 0,5 do 1 mln lat aby osiągnąć obecne rozmiary

Ultraslow growth rates of giant gypsum crystals
A. E. S. Van Driessche, J. M. García-Ruíz, K. Tsukamoto, L. D. Patiño-Lopez, and H. Satoh
PNAS 108, 15721–15726 (2011).

www.pnas.org/cgi/doi/10.1073/pnas.1105233108