Prenucleation nanoclusters as building units in the crystal growth

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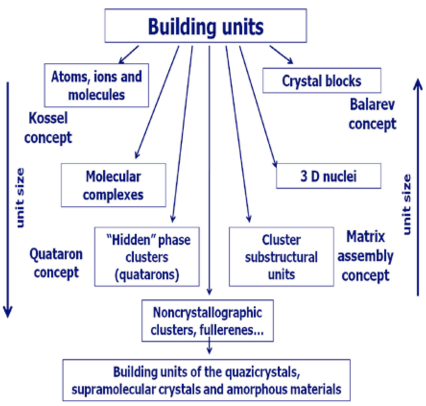
The problem of building units is central in the crystal growth theory. Throughout many decades there competed two conceptual ideas.

According to the first, crystals grow by joining to them of already formed in environment crystal blocks (Balarev concept). According to the second, building units are separate ions, atoms and molecules (Kossel concept).



In principle, realization of these two extreme variants does not contradict the general laws of physics and chemistry. As a matter of fact, the majority of modern theoretical models of crystals growth are constructed on their basis. At the same time, for a long time already another idea – on building units as particles larger than separate atoms or molecules, but not being crystalline particles (3 D nuclei) – is discussed. There were suggestions about participation in growth of crystals of intermediate formations (complexes, associates, clusters etc.) of which existence testified the results of numerous experimental (not only spectroscopic) researches of crystal-forming media. However on this basis it was not possible to develop the alternative concept of crystal growth because of arising contradictions with classical theory of nucleation.

We developed a new approach to the analysis of processes of nucleation and growth of crystals which comes from the possibility of formation and existence in supersaturated media of special forms of the connected atoms – nano-size pre-nucleation clusters of "hidden" phase called quatarons [1, 2]. Quatarons owing to their properties are ideal structures as building units. Namely they are the basic growth units and not geometrically and energetically stabilized clusters or another clusters substructural units. Thus an old problem of establishing the nature and sizes of building units in the process of crystals growth is solved.

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[1] Askhabov (2004) Proc. of the Russian Miner. Soc . CXXXIII, No.**4**, 108-123.[2] Askhabov & Kamashev (2012) Proc. of 34th Int. Geological Congress, Brisbane, Australia, 5-10 August. P. 2162.

Timing of Northern Hemisphere climate transitions during the last glacial period from precisely-dated speleothem data

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Previous $\delta^{18}O$ results of last glacial period precipitation variability in the south western United States from Fort Stanton cave, New Mexico (FS-2) [1], matched changes in Greenland temperatures [2]. We inferred changes in winter precipitation, which were related to changes in the meridional shifts in the position of the position of the polar jet stream, reflecting changes in the polar to equator temperature gradient in the Northern Hemisphere (NH).

We report high-resolution chronology and oxygen and carbon isotope data on another Fort Stanton Cave stalagmite (FS-AH-1), taking advantage of the higher growth rate compared to FS-2 (3 μm/yr vs 11 μm/yr), newer refinements in the half-lifes of ^{234}U and ^{230}Th, a new high purity ^{233}U-^{236}U spike and much improved efficiency from our upgraded Neptune multi-collector ICP-MS. The new chronology, between 48.4 -11.2 kyr B.P., has 2-σ errors in the range of 100 years for most of the segments, including conservative estimate of the uncertainties in the initial $^{230}Th/^{232}Th$ ratios.

Our results show that last glacial stadial (Heinrich Events, HE) and interstadial (Dansgaard/Oeschger Events, D/O) are matched very well in timing, amplitude and duration between the FS-AH-1 and NGRIP [2] with a higher age precision than the ice core data. The lack of systematic pattern in the lead-lag relationships between the ice core and FS-AH-1 D/O and HE chronology suggests that differences are due to chronology and not climatic lags. Thus, FS-AH-1 provides a more precise chronology for the NGRIP record. One significant difference, our record, similar to some North Atlantic records, shows two HE 1 cooling excursions, occurring immediately after two IRD (ice-rafted detritus) events [3] and match temperature sensitive $\delta^{18}O$ marine core data from subtropical Atlantic [4]. The difference between the two records may reflect greater sensitivity of our record to circulation-driven NH temperature gradient variability.

[1] Asmerom *et al*, 2010, *Nature Geoscience* **3**, 114- [2] Rasmussen *et al*, 2005, *GRL*, **111**, 1- [3] Bard *et al*, 2000, Science **289**, 1321- [4] McManus *et al*,2004, *Nature* **428**, 834-

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