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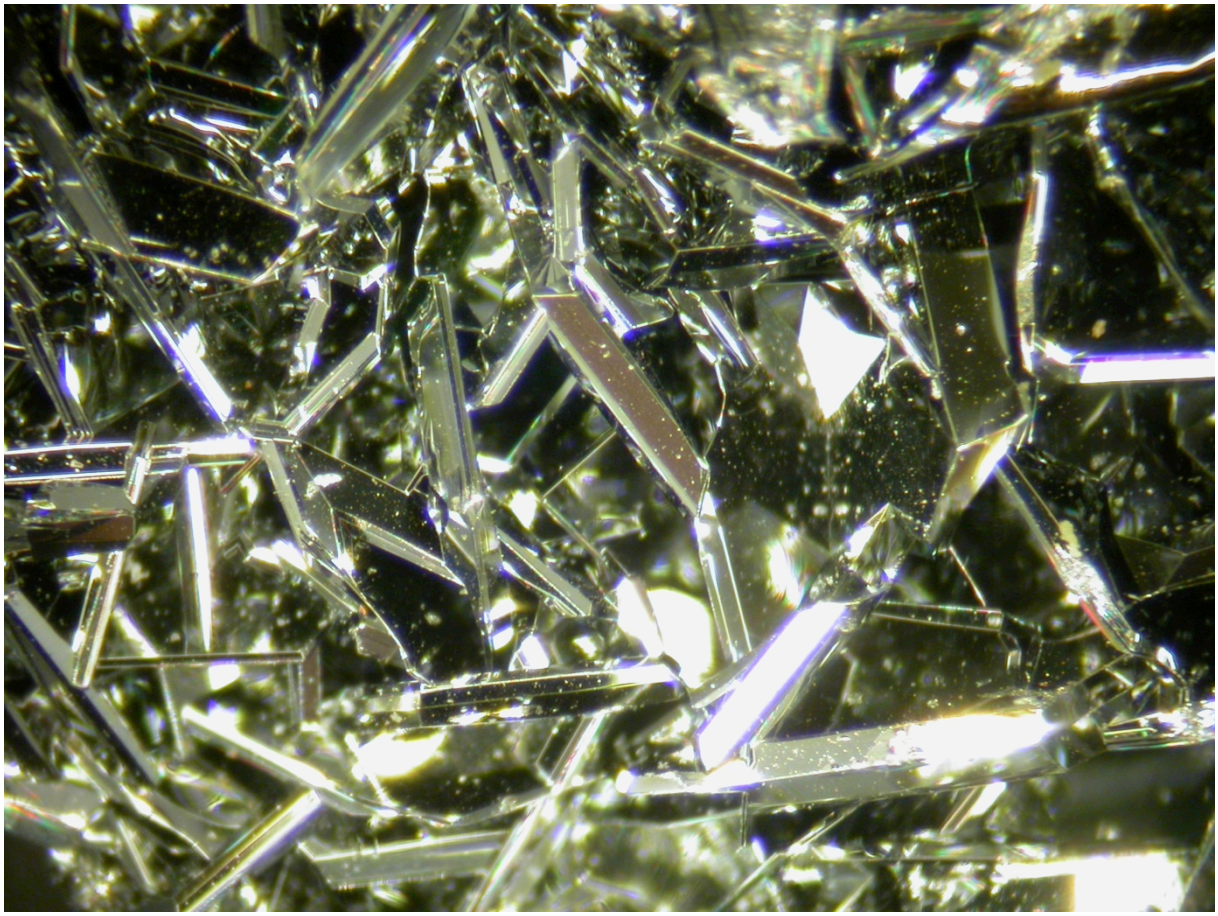

In this issue:

LET'S GROW NICE – BIG – PURE !
MINUTES OF A HAIR-RAISING CRYSTAL-GROWTH CONTEST FOR PUPILS

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2014 INTERNATIONAL YEAR OF CRYSTALLOGRAPHY: MAKE IT PUBLIC AND FUN!

Starting October 2013, it became obvious to a group of scientists from the *Chimiscope*, the *PhysiScope* and the Laboratory of Crystallography, University of Geneva, that "something had to be organised" for the general audience to commemorate 2014 International Year of Crystallography (IYCr-2014), which had been announced in 2012 by the UNESCO as a tribute to the centennial of X-ray diffraction.

Both at the international level (http://www.iycr2014.org/) and at the Swiss scale (http://www.sgk-sscr.ch/iycr2014/, website operated by the Swiss Society for Crystallography SSCr), a bunch of high-quality events were planned over the whole year 2014, with a focus on disseminating the front-edge knowledge on crystallography and its challenges among the general audience of non-specialists. In Switzerland, IYCr-2014 has been characterised in January by a special issue of Chimia, the international journal for chemistry published by the Swiss Chemical Society (http://chimia.ch), dedicated to the past, present and future of crystallography with 13 generous papers on the subject. By the end of February, Prof. Katharina Fromm, then President of SCNAT – Platform Chemistry and member of the SSCr, launched a public exhibition on crystals and crystallography in the University of Fribourg within the frame of its 125th anniversary; this exhibition opened its doors until mid-November. Then in March two wonderful stamps were issued by the Swiss Post in close collaboration with the President of the SSCr, representing spectacular crystals of natural epidote and amethyst. March was also the opportunity for the newspaper Neue Zürcher Zeitung to publish a long apology on crystals and crystallography in Switzerland, and for "Le Journal de l'UNIGE" to present an interview of Radovan Černý, head of the Laboratory of Crystallography, on the how's

and why's of the science of crystals. Finally, the commemorative year ended up with a long radio coverage of crystallography on RTS – La 1ère. And this is of course not to forget the monthly calendar of wonderful pictures listing all Swiss events, published during the whole year 2014 by the SSCr and available to everybody on the society's website.

Something however seemed to miss to the authors of this report: while the great majority of events were focused toward adults, apparently no action was to be organised specifically for children, although crystals and crystal growing are among the fascinating subjects driven by natural or artificial processes that are fairly easy to bring to the curiosity of youngsters. We thus ultimately decided to organise a contest for school classes in Geneva, as a contribution to the spreading of knowledge and passion on crystallography among the younger audiences.

This contest, "Clair comme de l'Eau de Roche – Grand Concours de Croissance du Cristal le plus Superlatif" (Crystal-Clear – The Most Superlative Crystal Growth Contest; see the flyer in Fig.1), has been designed for all public and private schools of the Primary, Secondary I and Secondary II levels in Geneva.

To our knowledge, this contest has been the only one of its kind in Switzerland, while several other crystal growing competitions have been organised in other countries (a paper on such a contest organised in the USA has been published in the November 2014 issue of J. Chem. Educ.).

One year later, it is time to make an assessment of the contest and its outcomes.

Figure 1. Flyer distributed to all Geneva schools to announce the launch of the contest.

THREE AGE CATEGORIES – ONE KIT

The objective of the contest was self-contained in its title: Growing the most superlative crystal... but not whichever crystal. The organising committee had to identify a salt which met three criteria to be eligible as the starting material for all categories of ages (Primary level, Harmos 1-8; Secondary I level, Harmos 9-11; Secondary II level, Harmos 12-15): First, the salt, in its solid or solution or crystalline forms didn't have to be toxic or harmful or dangerous for the environment; second, it didn't have to be easily identifiable to avoid teachers purchasing extra stock in order to enhance their chance to grow larger quantities of crystal; third, the crystal had to be uncomplicated to grow with simple material that can be found in every school. Options such as copper sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$; toxic and straightforward to identify) or potassium alum ($KAl(SO_4)_2 \cdot 12H_2O$; containing Al^{3+} suspected to be implied in breast cancer) were thus excluded, and the retained candidate was potassium dihydrogen phosphate (KH_2PO_4 KDP, CAS Nr. 7778-77-0; white salt with no prominent characteristic and no toxicity); this salt shows a high difference in its water solubility at room temperature (ca. 230g/L) and at 90°C (ca. 835g/L), and it forms nice transparent tetragonal monocrystals which can grow humongous under highly controlled conditions.

All participating classes received the same kit, containing 100g of the unknown salt, a plastic container to prepare the solution and sending back unused substances for proper waste elimination, a plastic box for returning the grown crystal, and a set of simple instructions and hints to produce the most superlative crystal. Of course, the word superlative had a different meaning for each category of age: For Primary level classes (category "Kids"), the crystal had to be the funniest or most original, thus leaving a large creativity in the hands of the participants; for Secondary I level classes (category "Juniors"), the crystal had to be the heaviest and most bulky, thus bringing students to the concepts of scientific and quantitative approaches; for Secondary II level classes (category "Seniors"), the crystal had to be the largest and most crystallographically pure, thus requiring advanced skill and patience during all steps of the process.

Kits were distributed to participants between mid-January and mid-April, to allow for the Awards ceremony to be organised mid-May, i.e. before the end of the school term.

CREATIVITY, SKILL, CHALLENGE, AND THEN PATIENCE

Approximately 200 teachers from Geneva were informed about the contest, and 90 kits were distributed to classes, thus reaching ca. 1800 students in Geneva. At the deadline, 54 samples had been returned to the organising committee, i.e. a very encouraging ratio of 60% of crystals returned. Actually, several teachers informed us that their growing process had been spoiled at a step or another by some disturbing parameters (mostly temperature or volume changes and sudden bulk crystallisation, but also because of improper reading of the instructions and hints); the authors

estimate that ca. 75% of all kits sent would have been returned as crystals if no team would have experienced troubles during the process.
The Table below summarises the main characteristics of the 54 crystal samples.

Category	Number of crystals received	Coloured crystals	Monocrystalline samples	Bulky samples
“Kids” (Primary)	25 (46%)	13 (52%)	10, partly (40%)	4 (16%)
“Juniors” (Secondary I)	14 (26%)	6 (43%)	10, partly (71%)	9 (64%)
“Seniors” (Secondary II)	15 (28%)	1 (7%)	14 (93%)	10 (67%)

The number of coloured samples (37% of all sets) was of a great surprise to the organising committee. Globally, the criteria required for becoming a winning crystal were followed in each category.
Evaluation of all samples and election of the Prize-winning crystals has been entrusted to the Jury, composed of Radovan Černý, crystallographer, Alan Francis Williams, chemist, Christoph Renner, physicist and Jacques Deferne, honorary curator of the *Musée d'Histoire Naturelle de Genève*. The ranking parameters used to evaluate the samples were as follows:

“Kids”: Score = 0.54×[Originality] + 0.36×[Beauty] + 0.1×[First Sight Impression]

“Juniors”: Score = 0.70×[Mass] + 0.015×[Originality] + 0.015×[Beauty] + 0.27×[First Sight Impression]

“Seniors”: Score = 0.75×[Crystallographic Quality] + 0.25×[Aesthetic Quality]
= 0.75×{(0.5×[Laue] + 0.25×[Visual Observation] + 0.25×[Polarised Light Observation]) × Log_{10}(Mass + 10)}
+ 0.25×{0.9×[First Sight Impression] + 0.05×[Originality] + 0.05×[Beauty]}
The Laue parameter was determined by recording the X-ray diffraction pattern produced by the monocrystal.

The apparently tortuous equation used for the evaluation of the samples provided by “Senior” classes allowed the Jury to take into account the crystallographic purity and the mass of the provided samples (both integrated under the parameter Crystallographic Quality).
Because of the large number of breath-taking samples received, the Jury ultimately decide to attribute a Special Prize to the crystal ranked fourth in each category. The table below summarises the statistics on all samples received.

Category	Maximum score	Average score	Median score	Minimum score
“Kids”	**5.4/6.0**	4.2 ± 0.7	4.3	2.8
“Juniors”	**5.7/6.0**	3.9 ± 1.2	4.2	2.1
“Seniors”	**6.0/6.0**	3.4 ± 1.5	2.8	1.7

Figure 2, extracted from the monthly calendar published by the Swiss Society for Crystallography during the year 2014, shows the four Prize-winning crystals in each of the three age categories.

Figure 2. *French version of the Crystallographic Calendar (July) published by the SSCr during IYCr-2014, showing the magnificence of all Prize-winning crystals. Pictures were taken by Lionel Windels on a mirror surface. Reproduced with kind permission of the Swiss Society for Crystallography.*

Complementing Figure 2, Figure 3 below shows some of the non-awarded crystals submitted during the contest. These crystals are definitely an arbitrary selection aimed at revealing to the reader the ingenuity of some participating classes, whichever their category. Thanks to the generous contribution of the Swiss Society for Crystallography and an anonymous Foundation active in science, the organising committee has been able to produce a luxurious catalogue exhibiting all crystals submitted, which has been offered to all participating schoolchildren after the award ceremony.

Figure 3. *Selection of some of the crystals submitted to the contest.*

By mid-May, the 12 Prize-winning classes were invited to participate in the final ceremony, which took place in the Faculty of Science, UNIGE, in the presence of the organising committee and the members of the Jury. The latter offered three presentations that intermingled history, science of crystallography and famous scientists (Wilhelm C. Röntgen and Max von Laue), order and disorder in Nature and in the research or industrial laboratory, and humour. Then Prizes were distributed to the award-winning classes. These Prizes are shown on Figure 4 below.

Figure 4. *First, second and third Prizes, and Special Prize, distributed to all award-winning classes during the ceremony.*

The first and second prizes for each category were large cubes of glass with a laser engraving showing the 3D structure of potassium dihydrogen phosphate monocrystals. The third prize was a 3D ball & stick model of this structure. And the fourth prize was a set of two scientific books related to chemical elements and atoms. All schoolchildren in the award-winning classes also received a nice quartz crystal. The ceremony was complemented by a nice tea party where students, teachers and researchers enjoyed sharing their enthusiasm for crystals.

But the nice story of this contest didn't end at the ceremony. In July 2014, all crystals were on exhibit during the 10th edition of the *Nuit de la Science*, organised around the *Musée d'Histoire des Sciences de Genève* (see Figure 5) where ca. 35'000 visitors gather every other year.

Finally while the minutes of the event were published in the December issue of the journal Chimia, all details on the contest, including pictures of all crystals and the luxurious catalogue, have been made available on the website of the *Chimiscope* (http://chimiscope.ch).

Figure 5. Crystals on display during the *Nuit de la Science*, July 2014, in the *Perle-du-Lac* gardens, Geneva.

AND SO WHAT?

After the lights of the contest were switched off, the organising committee noticed that the significantly increased number of visits at the *Chimiscope* and the *PhysiScope* had been booked by many of the teachers who initially participated in the contest with their classes. This observation has convinced the organisers that a unifying event focused on science and youngsters can have unexpected and positive consequences in terms of incentive interactions between researchers and schoolchildren.

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