HOW WE USED THE NASA LUNAR SAMPLE SET IN THE PLANETARY AND MATERIAL ANALOG STUDIES: LUNAR AND INDUSTRIAL IMPLICATIONS FROM THE COMPARISON OF TEXTURES AND PROCESSES. Sz. Bérczi[1], Sz. Nagy[1,3], I. Gyollai[2], S. Józsa[1], Gy. Szakmány[1], T. N. Varga[1], T. P. Varga[1], A. Gucsik[4,5]. [1]Eötvös University, Institute of Physics, Department of Materials Physics, CMSRG, H-1117, Budapest, Pázmány Péter sétány 1/a, Hungary, (bercziszani@ludens.elte.hu); [2]University of Vienna, Department of Lithospheric Research, A-1090, Vienna, Althanstrasse 14., Austria, [3]Szeged University, Dept. Mineralogy and Petrology, H-6722, Szeged, Egyetem u. 2-6., Hungary, [4]Osaka University, 1-1 Machikaneyama, Toyonaka, Osaka 560-0043, Japan, [5]Konkoly Observatory of the Hungarian Academy of Sciences, H-1121 Budapest, Konkoly Thege Miklós út 15-17., Hungary

Introduction: NASA Lunar sample educationnal set is an ideal collection in teaching material science through textures [1]. We could experience such benefits during our studies and teachings in the last 18 years of NASA set use. Both natural and industrial processes have common primary parameters [2] and exotic lunar petrographic cases make attractive this subject. Here we give an overview of some basic benefits:

Structural hierarchy of materials: Structural hierarchy is the first main introductory synthesis, which helps to place the observed phenomena among the scales and sizes (Fig.1.).

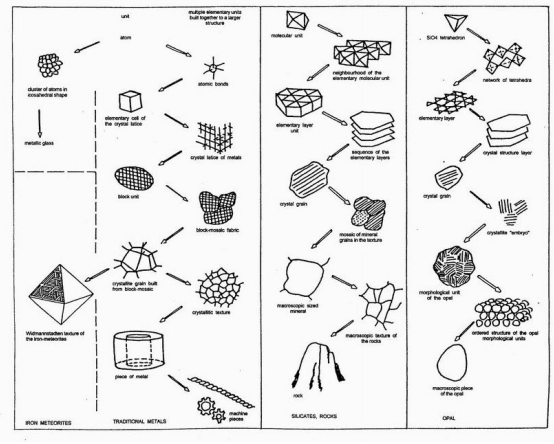

Fig. 1. Structural hierarchy of some solid crystalline materials: steel, rock, opal (with specific hierarchy). On the left end, there are branchings to meteoritic structural elements. In a material column left is the element, which builds up the next hierarchy level. Arrows point this structure [2].

Lunar and Industrial Comparison of the counterpart textures and processes: Textural analog studies play the most important role in our space materials education courses. Students know basics on petrographic textures and fundamentals of the macroscopic materials, the realm of the textural world is opened for them in the optical microscope [3,4].

Industrial technology procedures: These procedures are forced motions for the materials. Therefore, it is important to show that a path exists, formed from machines as well as the leading processes, which can direct the transformations of the materials. In the case of natural processes, the resulted texture is the interplay of natural effects, however, in the industry these steps were planned. An example is shown from aluminum industry (Fig. 2.).

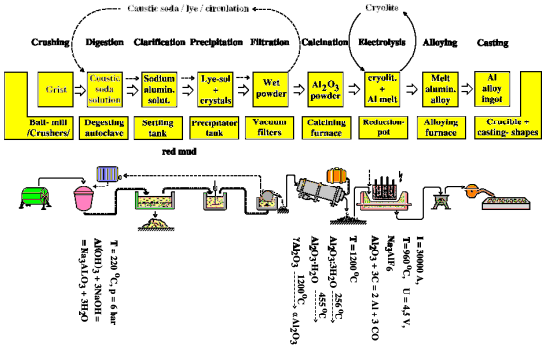

Fig. 2. The main operations in the alumina industry procedure. Squares show the materials, while the oblong at bottom exhibits the instruments, which force the procedure.

72275 and ceramic industry: The first analog study in respect of lunar and industrial processes and textures is that for breccias and ceramics.

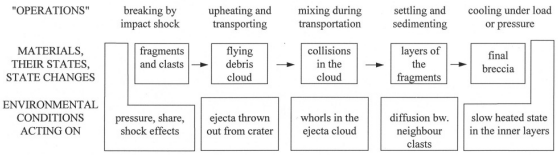

Fig. 3. The main operations in the impact process is incidental, as compared to ceramic procedures

Technology procedure contains grind at the initial stage and then mixing, forming, heating and final burning (burnout) and cooling. In the impact process these "operations" of the procedure is incidental (Fig. 3. and 4.), while in industry it is austerely controlled [6].

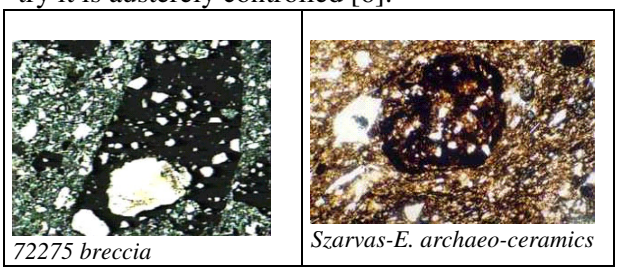

Fig. 4. Apollo 17 breccia which shows breccia-in-breccia regions. Szarvas-Endröd sample is from an archaeo ceramic.

12002, 70017, 12005 and steel industry: Basalts and steels were found as analogs on the basic parameter of textures: the cooling rate. The main processing step is the cooling, and we summarize the effect on Figure 5.

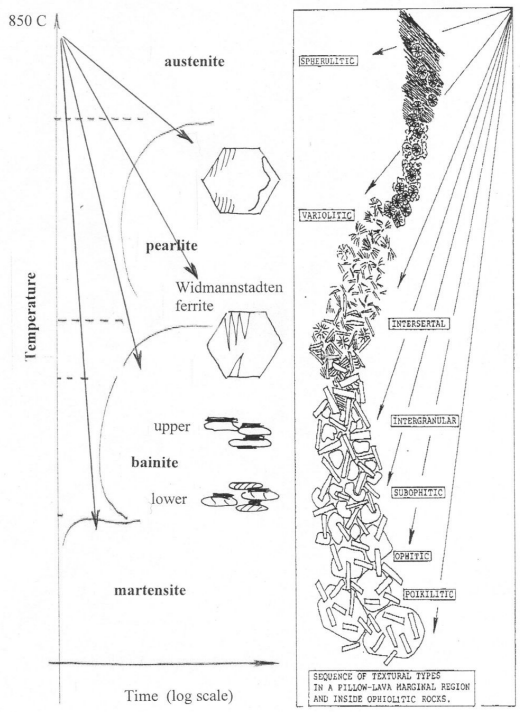

Fig. 5. Two counterpart Temperature-Time-Transformation (TTT) diagrams: on the left the steel industry TTT contains the main textural types of steels: martensite, bainite, pearlite and the initial austenit; on the right the basaltic textures are arranged in a cooling rate sequence from the bottom: poikilitic, ophitic, subophitic, intergranular, intersertal, variolitic and spherulitic [2,5].

12002 and the fiberglass industry: The 12002 basaltic sample contains thin needles of pyroxenes. This mineral prefers a needle form in rapid cooling conditions and a special fiberglass industry, the basaltic-fiber producing technology is the counterpart, even the factory was visited in some courses in Tapolca, Hungary [7]. There the melted basalt of Diszel quarry (also visited as Apollo landing site analog, near Tapolca) is flowed on rolling steel cylinders and the precipitating needles are handled in a procedure to form fiberglass elements for architectural industry.

74220 and glass industry: Orange soil samples represent special cooling rate indicators. The distinction between black and orange colored droplets is caused by the colloidic fine iron-oxide minerals precipitation initiated in the slower cooling droplets. (The flight of the black droplets was longer in the hot gases, while orange glasses were dropped quickly to the cold surface.)

Results: Students were active in finding textural counterparts of the studied lunar samples. Ceramic industrial cases were also studied in archaeometric context, too. Synthesis was the most valuable achievement, as students told about this during courses. It was easier to begin the physical chemistry course with the basis of textural studies of so far and yet analogous processes. This indicates that students can understand easily a relationship between lunar sample formation in volcanism and impacts and industrial technologies.

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