Crystallite-size model for siliceous concretions

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Some properties of ± pure siliceous concretions such as flint (synonym: Feuerstein or chert (synonym: Hornstein), for example: density, alkali solubility, H_2O-absorption, specific surfaces, whethering resistance, solubility rates or sensibility to alkali reaction (when used as aggregates in concrete), are sufficiently explicable by a crystal-size model given in fig. 1, which may be valid for all siliceous concretions containing ± only quartz of different states, although it has been verified so far only for baltic glacial flint (investigations following below) and indirectly for chert from Ohio by KNELLER et al. (1968).

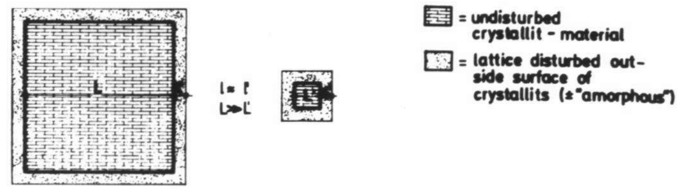

Fig. 1: Crystallite size model for flints (and cherts)

If one takes for granted that all quartz crystals have a well ordered 'core' (brickwork pattern in fig. 1) with a 'skin' of always equal thickness with continuously growing structural disorder to the outside surface (dotted pattern in fig. 1) and subsequent lower density, then the density of siliceous concretions should increase with growing crystal sizes. This postulated correlation is proved in fig. 2 + 3, where the crystal sizes are characterized by specific surface data, measured for four different bulk density classes (fig. 2) and respective total densities (fig. 3) of $^1/_2$ to. of baltic glacial flint material from 8 different deposits. The different densities are not due to various porosities (compare fig. 2 with fig. 3, bulk density versus total density), different silica modifications (microscopically and by X-rays only quartz has been observed) or different chemical composition (proved by chemical analyses).

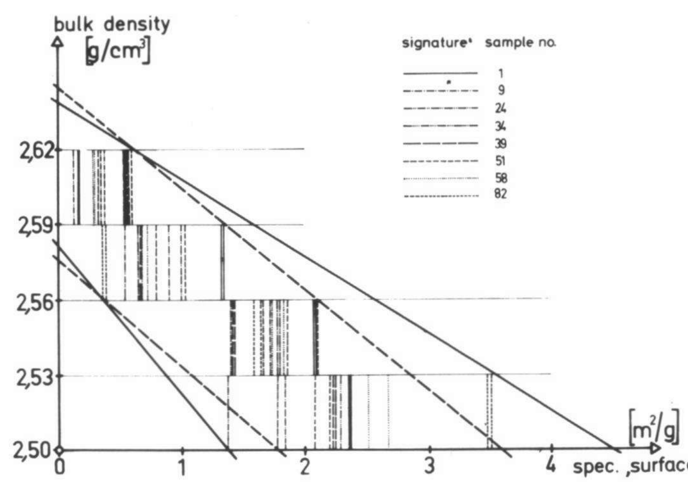

Fig. 2: Bulk density versus specific surfaces for baltic glacial flint from 8 different deposits.

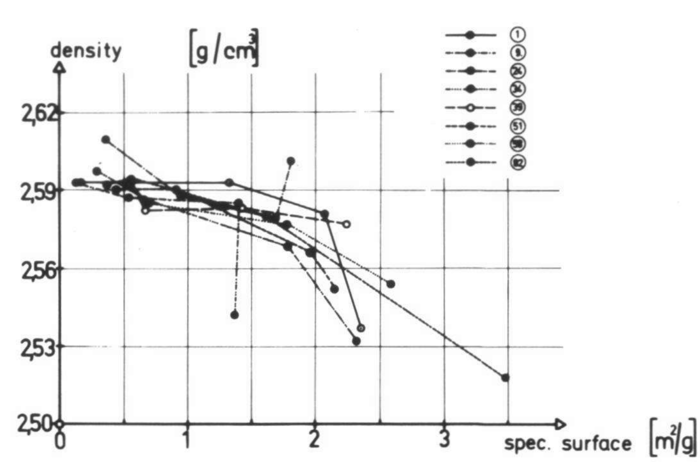

Fig. 3: Total density versus specific surfaces for baltic glacial flint from 8 different deposits.

Moreover growing amounts of disordered silica with decreasing densities have been measured (by X-ray powder diffractometry, differential thermal analysis and solubility tests).
To be of measurable effect on the density of the silica rocks according to the above model the quartz crystals should be rather small, to have influential amounts of disordered 'skins'. By electron microscopy, surface measurements and X-ray diffractometry the quartz-crystallite size of flints have been determined to vary between some microns and ca. 50 Ångstroms, in good agreement with literature data (e.g.: FOLK & WEAVER, 1952; DRENCK, 1959; TOVBORG, 1957).
Thus all postulates of the above 'crystallite-size model' have been satisfied for the investigated baltic glacial flints:
1. the silica rocks are of ± monomineral composition (quartz),
2. the different densities of flints are not due to varying porosities or various chemical impurities,
3. the quartz crystals are very small,
4. the crystal sizes increase with increasing densities (both bulk density and total density).
To show the relevance of this model two examples from concrete-tech nological spheres are given in fig. 4 and 5:

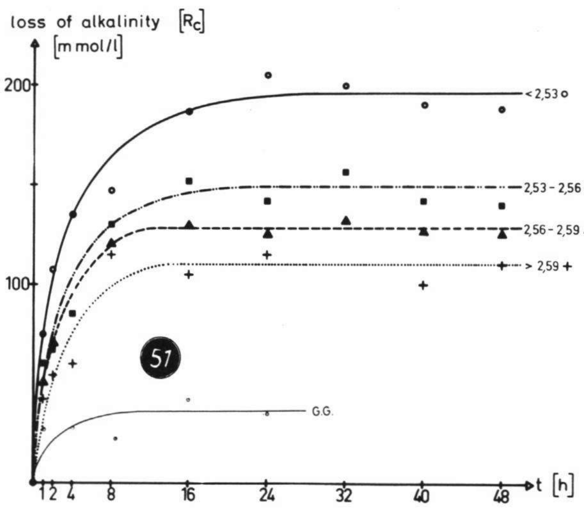

Fig. 4: Loss of alkalinity versus duration of autoclave treatment. Method according to ASTM-C-289.

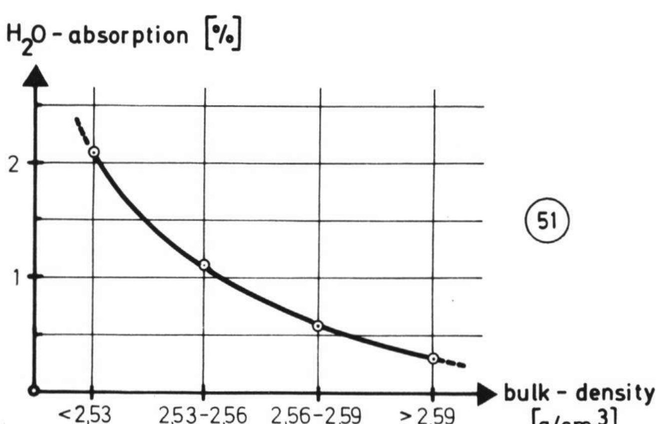

Fig. 5: H_2O-absorption versus bulk density. Method according to DIN 4266, Bl. 3, 5.1.

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*FOLK, R. L. & WEAVER, O. E., Amer. J. Sci., **250**, 498-510 (1952)*
KNELLER, W. A., KRIEGE, H. F., SAXER, E. L., WILBANDS, J. T. & ROHRBACHER, T. J., Aggr. Res. Grp., Geol. Civ. Eng. Dept., Final Rep. No. 1014, Toledo, Ohio (1968)
*TOVBORG, J. A., Dan. Natl. Inst. Bldg., Res. Prog. Rept., D, **1**, 1-37 (1957)*