Evidence of the anthropogenic origin of the "Carmel sapphire" with enigmatic super-reduced minerals

E. Galuskin and I. Galuskina
Faculty of Natural Sciences, Institute of Earth Sciences, University of Silesia, Poland
evgeny.galuskin@us.edu.pl, irina.galuskina@us.edu.pl

Supplementary figures

Fig. S1 Profiles of exploratory drilling in the development of alluvial deposits along the Kishon River. From the open presentation of the Shefa Yamim company
https://www.shefagems.com/wpcontent/uploads/2020/11/Shefa_Gems_CPR_Dec_2019.pdf

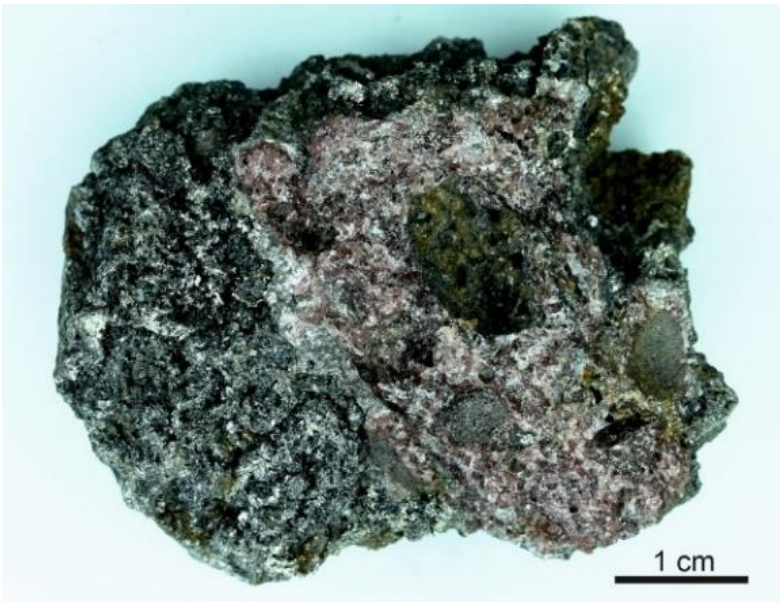

Fig. S2 Grain aggregate of pink synthetic corundum with FeSi(+Ti) alloy – slag from the lower part of the electric furnace for fused alumina production.

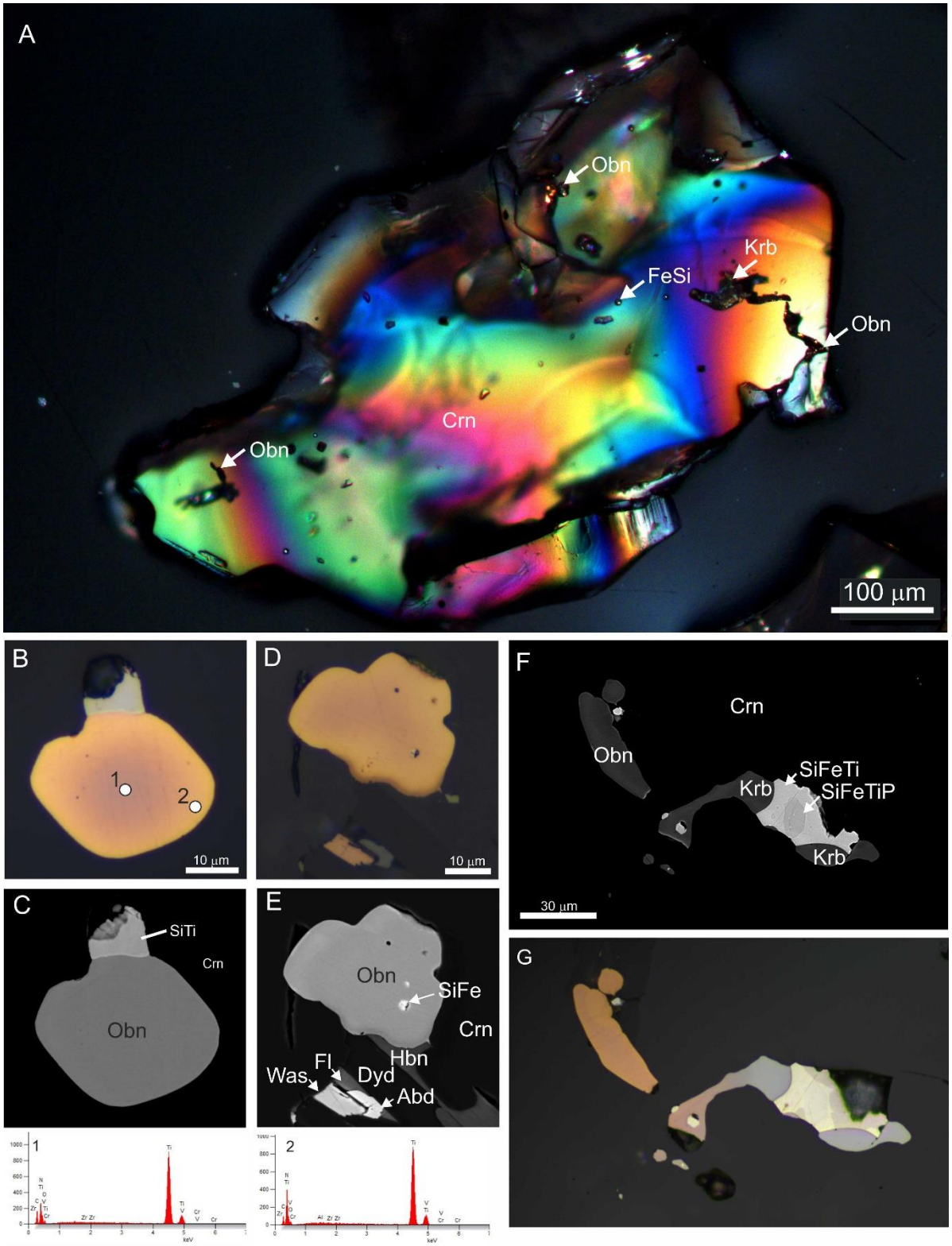

Fig. S3 A – Grain of synthetic corundum with **SR** phase inclusions analogous to the ones described in **CS**. B-E – Cross-sections of needle-like crystals of osbornite. B, D – Reflected light; C, D – BSE images. B – 1, 2 – points of EDS spectra shown below. F, G – Character of appearance of osbornite and khamarbaevite in association with inhomogeneous SiFeTi(+P) alloy. Abd = allabandite, Crn = corundum, Dyd = diaoyudaoite, Fl = fluorite, Hbn = hibonite, Krb = khamrabaevite, Was = wassonite, Obn = osbornite; SiFe, SiFeTi, SiFeTiP = alloys.

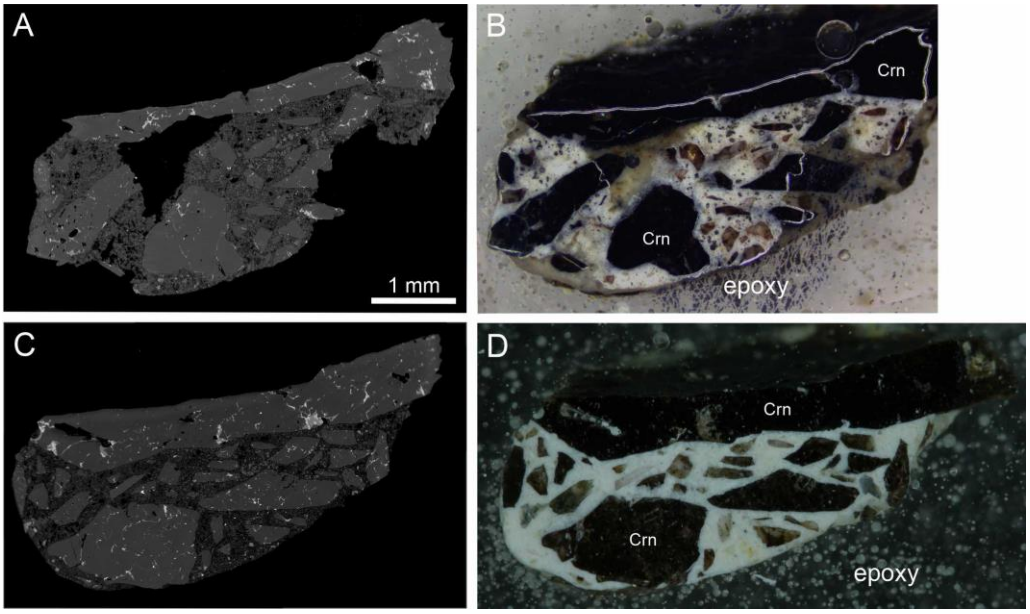

Fig. S4 "White breccia" with **CS** fragments of different size. A, B – First polishing of sample; A – BSE image, B – binocular microscope, remains of carbon coating are visible. C, D – Re-polishing of sample; C – BSE image, D – Optical image. Crn = corundum.

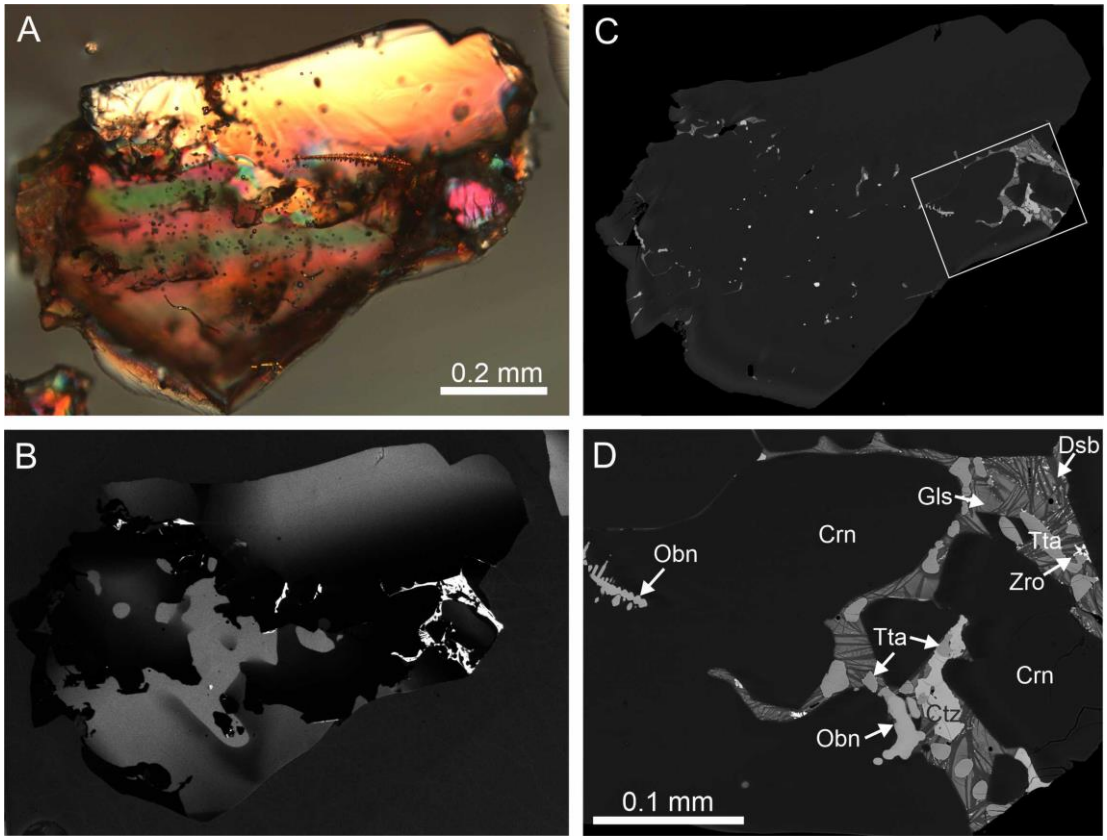

Fig. S5 A, B – Grain of corundum from "white breccia" with **SR** minerals. A – Optical image, osbornite skeleton and small balls of SiFe(±Ti) alloy are clearly visible; B – Cathodoluminescence image underlined growth inhomogeneity of corundum. C – BSE image, fragment magnified in Fig. S4D is shown in frame. D – Typical for **CS** mineral association (described by Griffin at al. 2018-2021). Crn =

corundum, Ctz = carmeltazite, Dsb = dmisteinbergite, Gls = glass, Obn = osbornite, Tta = tistarite, Zro = ziroite.

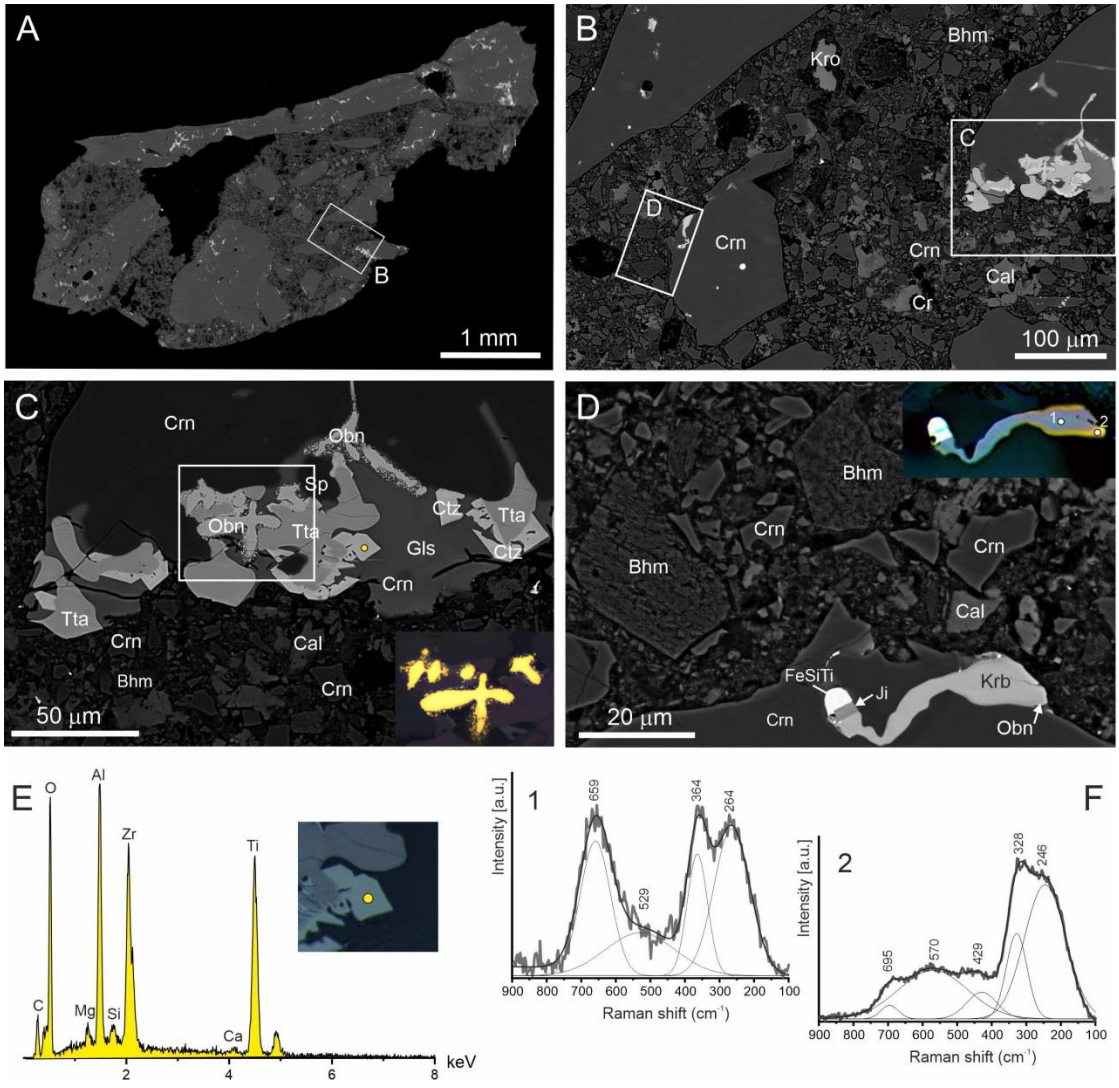

Fig. S6 Osbornite in corundum from "white breccia". A – Common view of mount, fragment magnified in Fig. S5B is shown in frame. B – Fragment of "white breccia", areas magnified in Fig. S5C, D are shown in frames. C – Skeletal crystals of osbornite in association with tistarite and carmeltazite. Yellow circle indicates a place of EDS analysis. Optical image of area outlined by frame is in inset in the right lower corner. In the optical image osbornite emulsion around osbornite skeletal crystals is visible. D – Khamarbaevite with thin rim of osbornite, which is clearly visible in reflected light, image is in inset. Numbers indicate places of Raman spectra measurements. E – EDS spectrum of carmeltazite. F – 1 – Raman spectrum of khamarbaevite, 2 – Raman spectrum of osbornite. Bhm = böhmite-like mineral, Cal = calcite, Cr = graphite, Crn = corundum, Ctz = carmeltazite, Gls = glass, FeSiTi = alloy, Ji = jingsuiite, Krb = khamrabaevite, Kro = krotite, Obn = osbornite, Sp = spinel, Tta = tistarite.

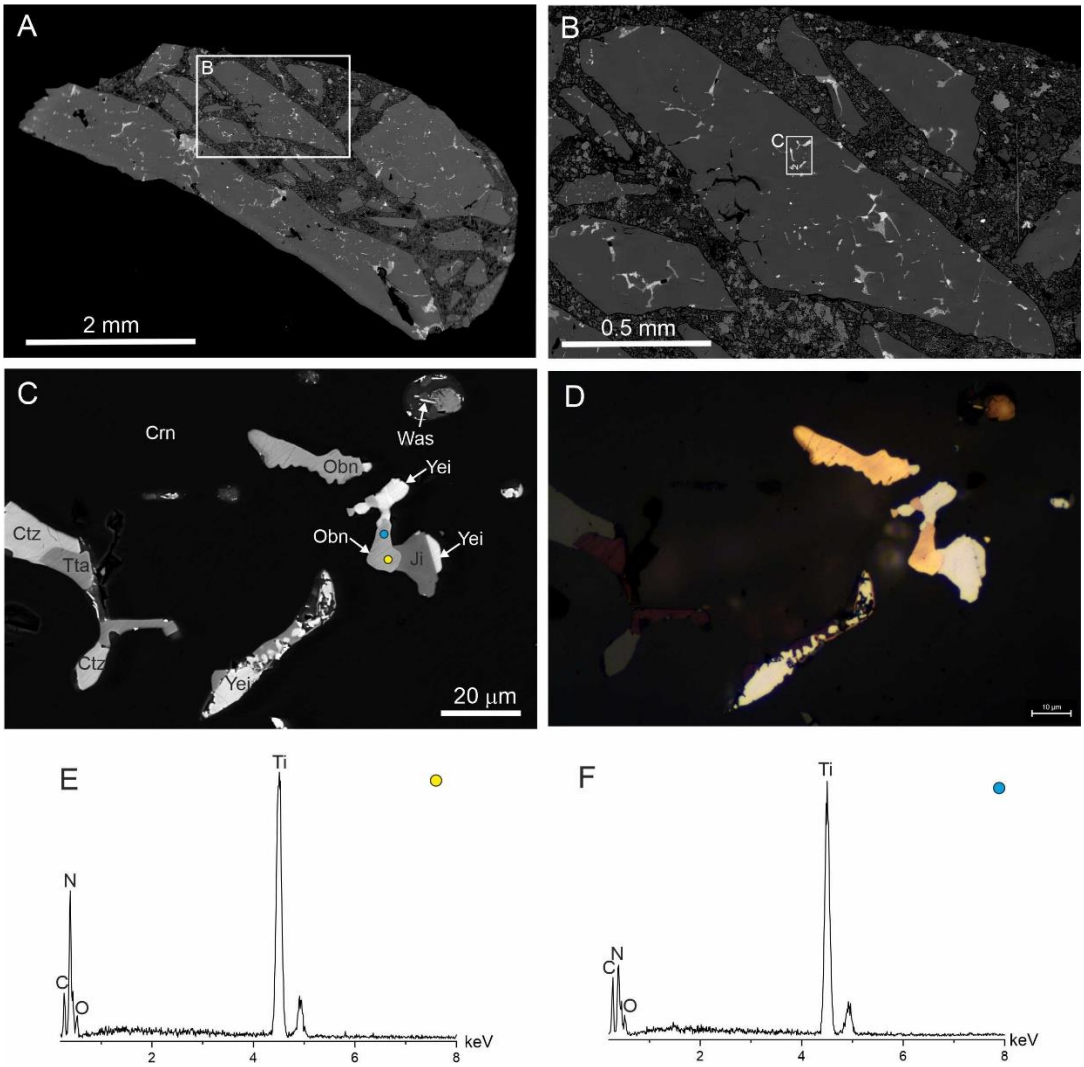

Fig. S7 Titanium minerals in **CS**. A – Common view of mount from "white breccia"; fragment magnified in Fig. S6B is shown in frame. B – Big grain of **CS** with different inclusions; magnified fragments in Fig. S6C, D are shown in frames. C, D – Various Ti-bearing minerals: wassonite TiS, osbornite TiN, jingsuiite TiB_2, tistarite Ti_2O_3, carmeltazite $ZrAl_2Ti_4O_{11}$, yeite TiSi. C – BSE image; points of EDS analyses of osbornite (yellow circle) and C-bearing osbornite (blue circle) are shown. D – Reflected light. E – EDS spectrum of osbornite. F – EDS spectrum of C-bearing osbornite. Crn = corundum, Ctz = carmeltazite, Ji = jingsuiite, Obn = osbornite, Tta = tistarite, Was = wassonite, Yei = yeite.

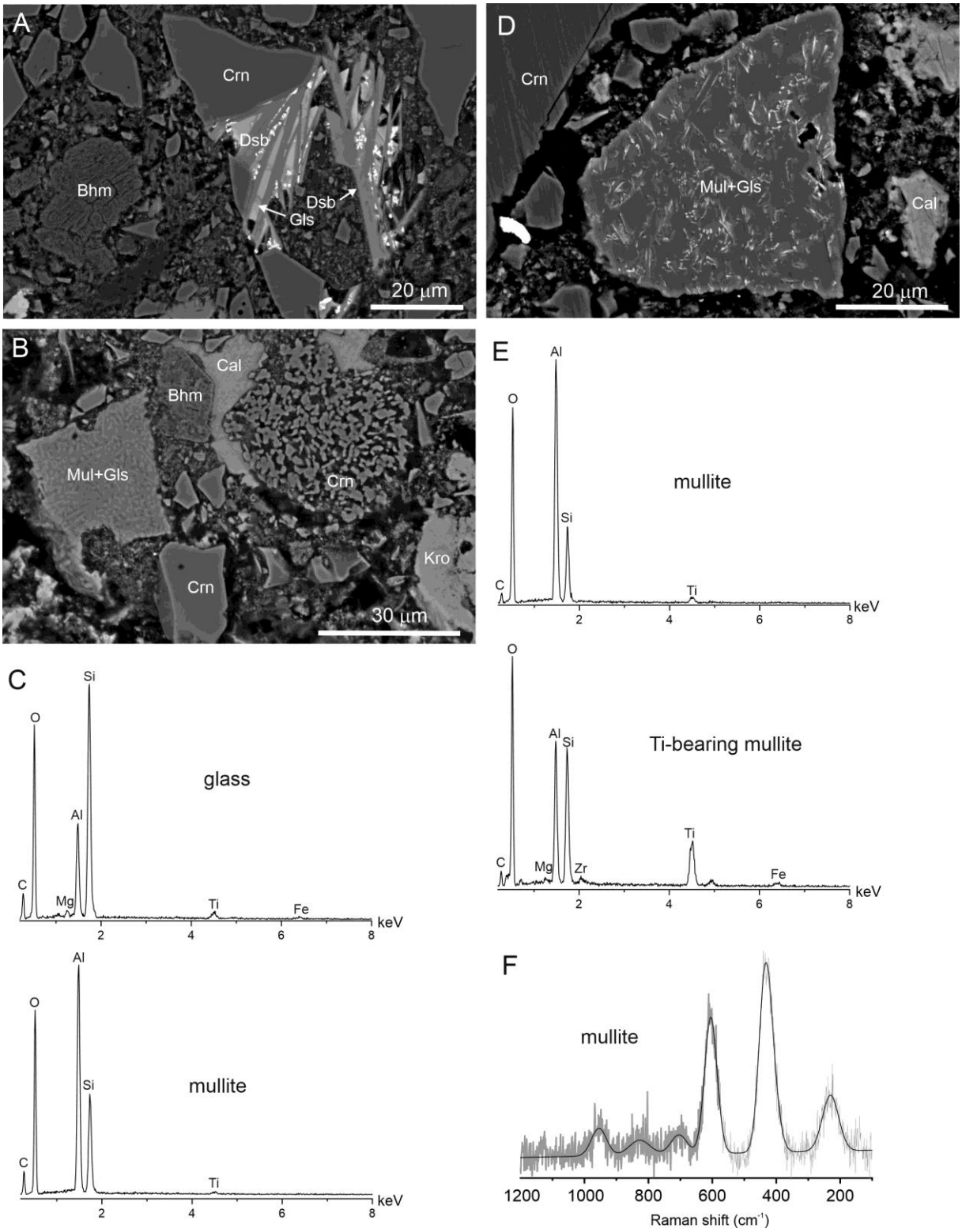

Fig. S8 A – Fragment of **CS** and glass with dmisteinbergite in "white breccia". B – mullite with glass. C – EDS spectrum of mullite and glass obtained from grain shown in Fig. S8B. D – Aggregate of mullite with small amount of glass ingrowths. Rims of mullite grains are enriched in Ti. E – EDS spectra of mullite and Ti-bearing mullite. F – Raman spectrum of Ti-bearing mullite. Bhm = böhmite-like mineral, Cal = calcite, Crn = corundum, Dsb = dmisteinbergite, Gls = glass, Mul = mullite.

Fig. S9 “White breccia” with **CS** (https://www.mining.com/new-mineral-found-inside-gemstones-israel)