Methods

Dissolution experiments

Dissolution experiments were only conducted on chromitite prisms from the Black Thor deposit. One of these prims (dimension of ~0.5 x 0.5(1) x 0.1cm) was treated with a standard 25 mL sulfuric acid solution of pH 2.5 containing additionally 0.51 g/L^{-1} of $(NH_4)_2(SO_4)$, $Mg(SO_4)(H_2O)_7$ and K_2HPO_4 (nutrients for cultivated bacteria from an AMD system; results from dissolution experiments with these bacteria and other chemical compounds under various pH-conditions are reported elsewhere). The solution was continuously agitated for one month at room T (final pH value 2.6) and subsequently prepared for Optical Microscopy (OM), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM).

Electron microscopy, Focused ion beam (FIB) technology and Microtomy

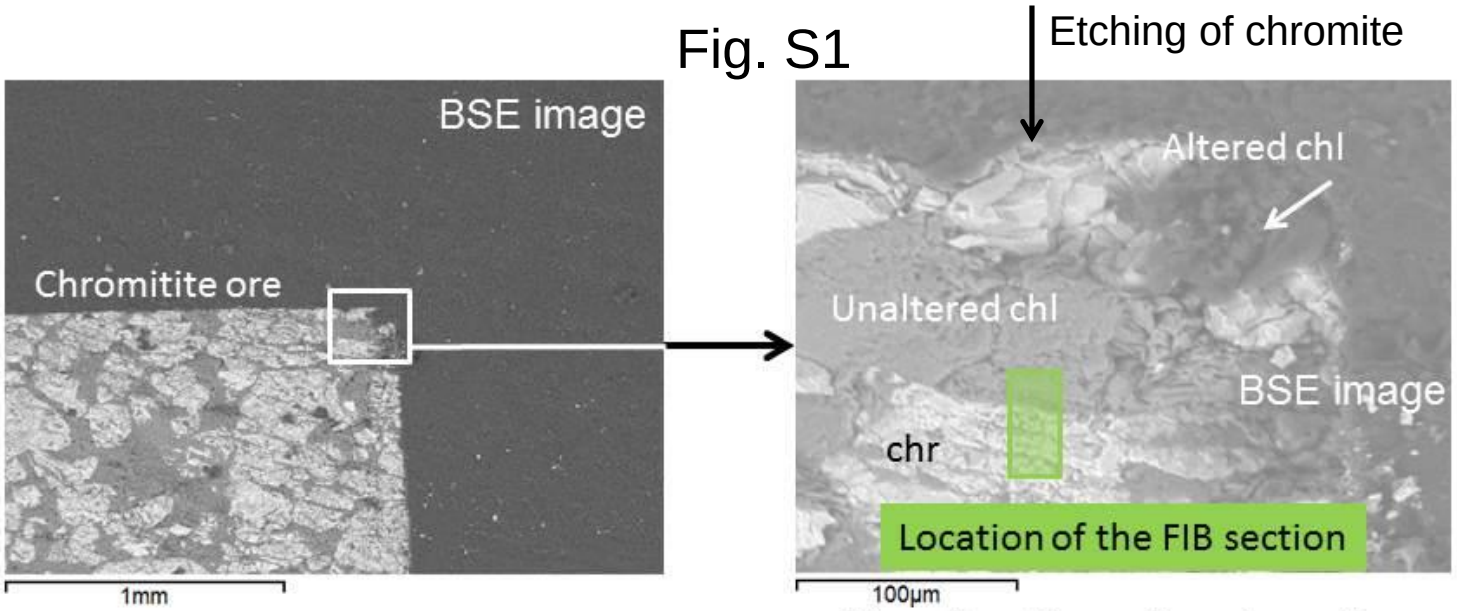
Scanning Electron Microscopy (SEM) was conducted with a JEOL 6405 at 20 kV, equipped with both backscattered (BSE) and secondary (SE) electron detectors and an Energy Dispersive X-ray Spectrometer (EDS). Scanning Transmission Electron Microscopy (STEM), High Resolution Transmission Electron Microscopy (HR-TEM), and Selected Area Electron Diffraction (SAED) were used to characterize the mineralogical and chemical composition of areas inside (representing an unaltered environment) and on the surface of a treated chomitite sample from the Black Thor deposit (representing an acid mine drainage environment). The FIB sections were extracted with a FEI Helios 600 NanoLab FIB, subsequently lifted using a platinum gas-glue, and thinned to electron beam transparency by ion gas milling (Ga ions). Microtome sections were prepared from a Cr-rich silicate from the Mistake Mine, California.

TEM studies were conducted with a JEOL 2100 field thermionic emission analytical electron microscope.. Measurements were taken with an accelerating voltage of 200 kV and a beam current of approximately 107 µA. EDS point analyses and maps were acquired in STEM mode with a JEOL BF detector (STEM)and JED-2300T silicon drift EDS detector with a 60 mm^2 window. SAED patterns were acquired using a Gatan Orius SC200D detector.

Chromitite ore sample from the Black Thor deposit, Ontario, Canada

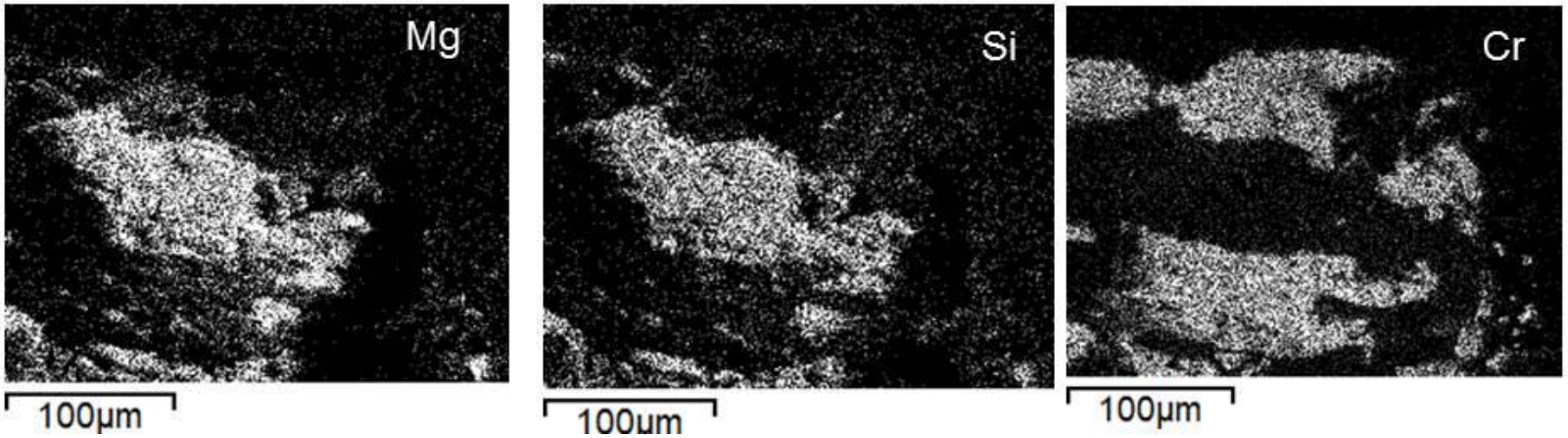
Location of the FIB section representing the unaltered part of the chromitite ore

Fig. S1



EDS-SEM chemical distribution maps

chl = clinochlore, chr = chromite



Location of the FIB section representing the altered part of the chromitite ore

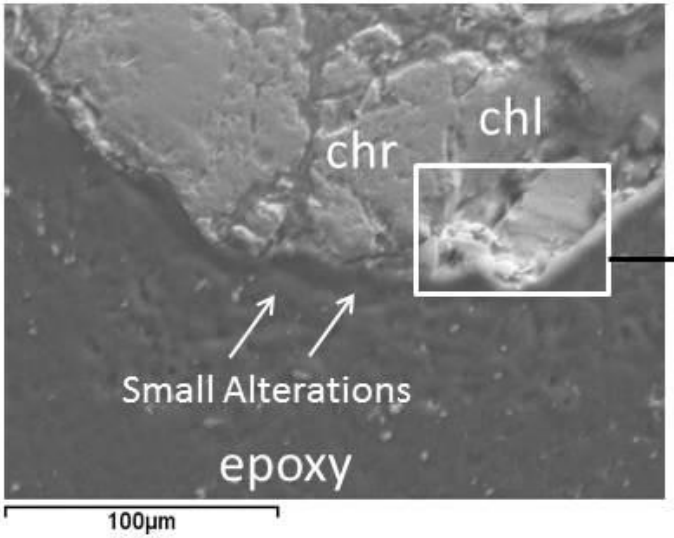
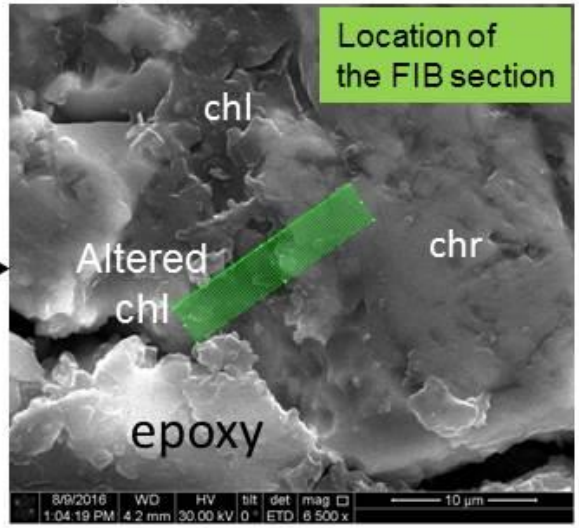
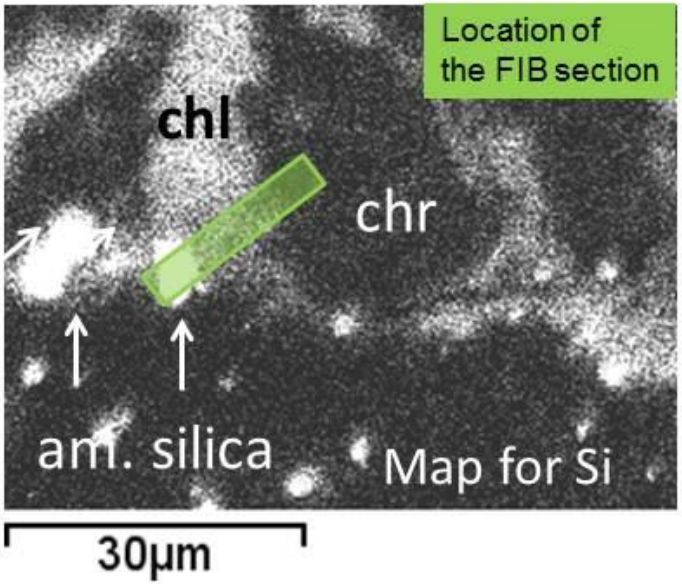
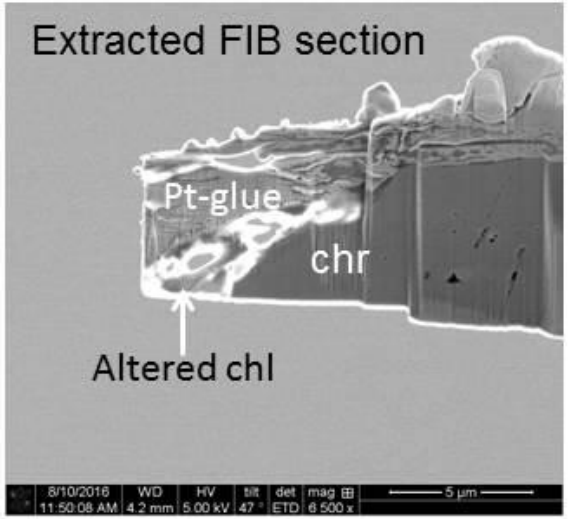


Fig. S2

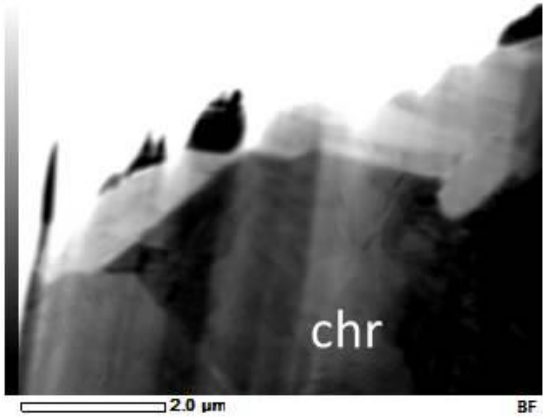


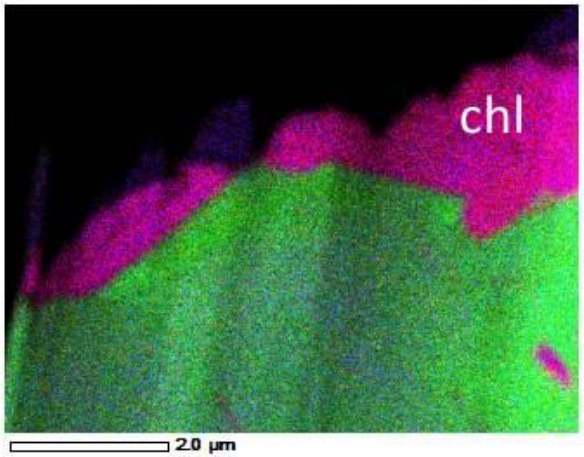
chl = clinochlore, chr = chromite





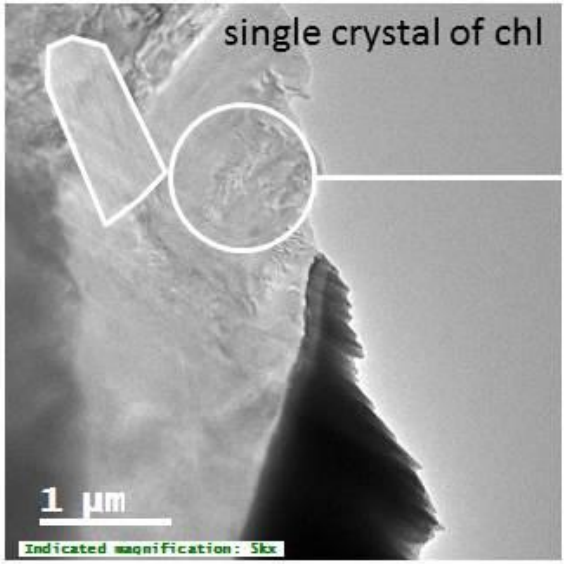
TEM images, EDS-STEM chemical distribution map and SAED pattern of untreated sample

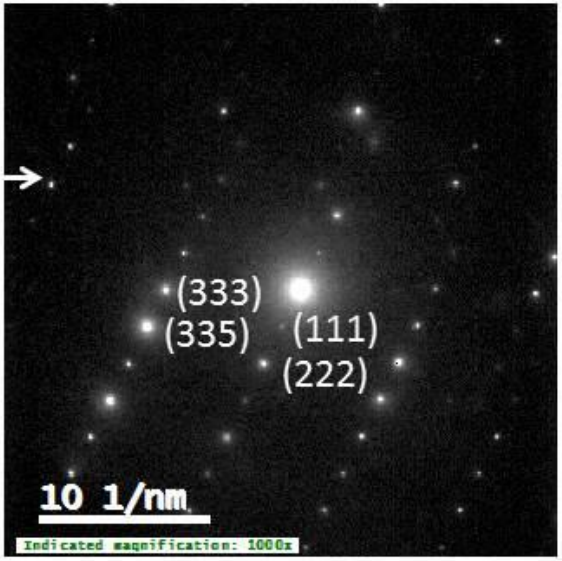




Cr: green
Mg: blue
Si: red

Fig. S3





SAED pattern with large diffraction aperture (large area)

d= 4.25 (111)
d = 2.12 (222)
d= 1.42 (333)
d= 1.29 (335)

TEM images, EDS-STEM chemical distribution map and SAED pattern of untreated sample (continue)

Chromite nano-particles in chlinochlore matrix

Diffraction spots for clinochlore single crystal
d= 4.5 (111)
d=3.4 (113)
d=2.58 (131)

Diffraction rings for Chromite nanoparticles
d= 2.06 (400)chr
d=1.47 (440)chr

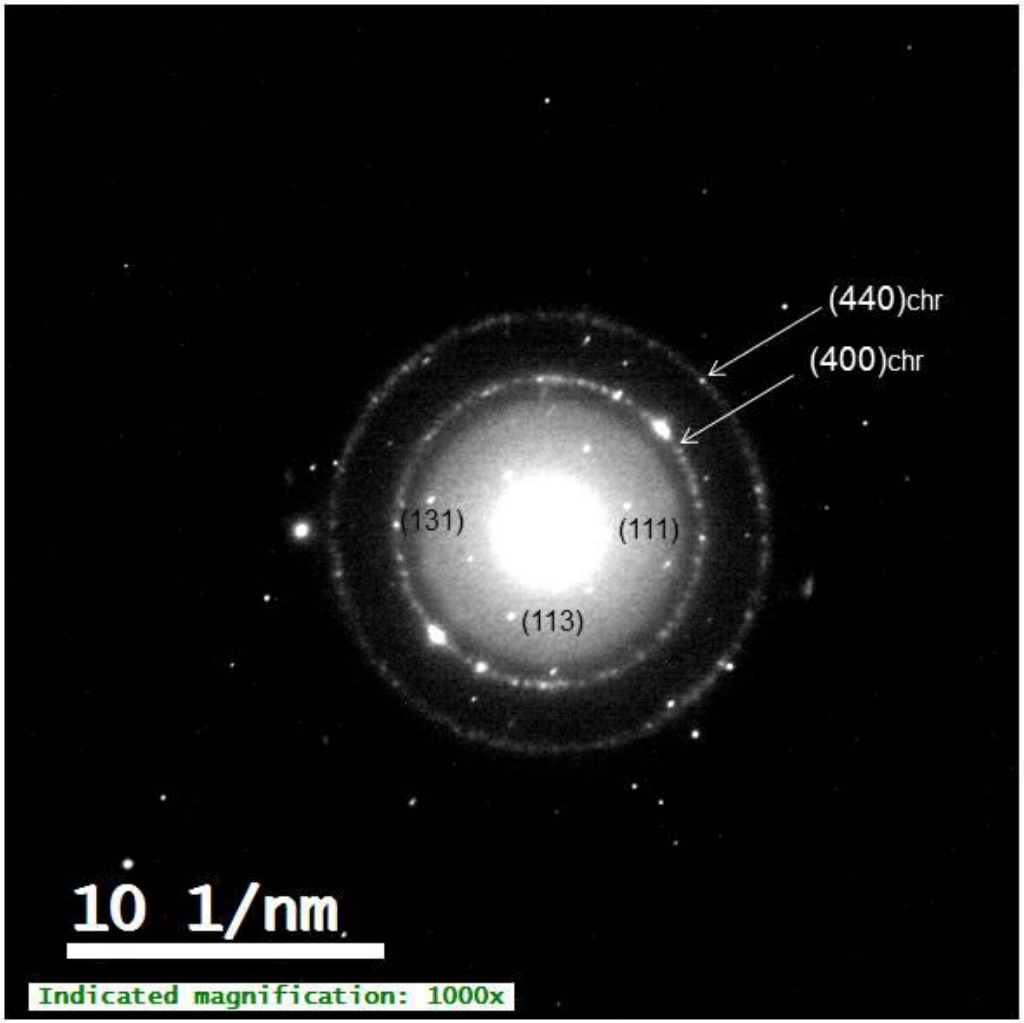
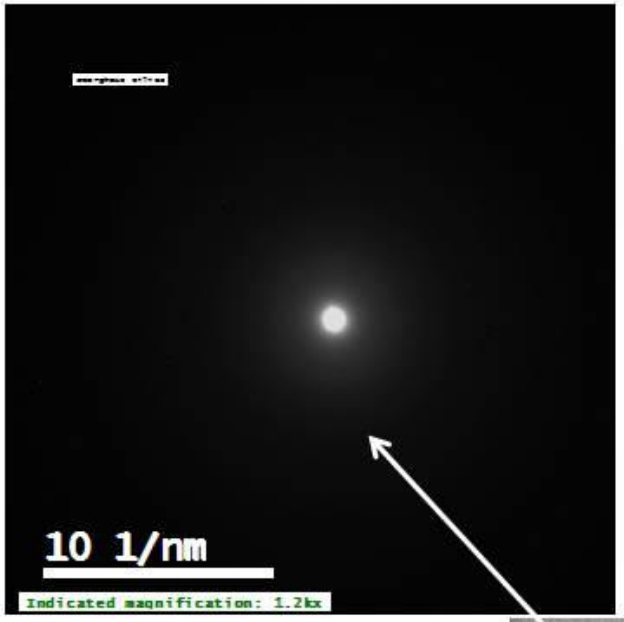


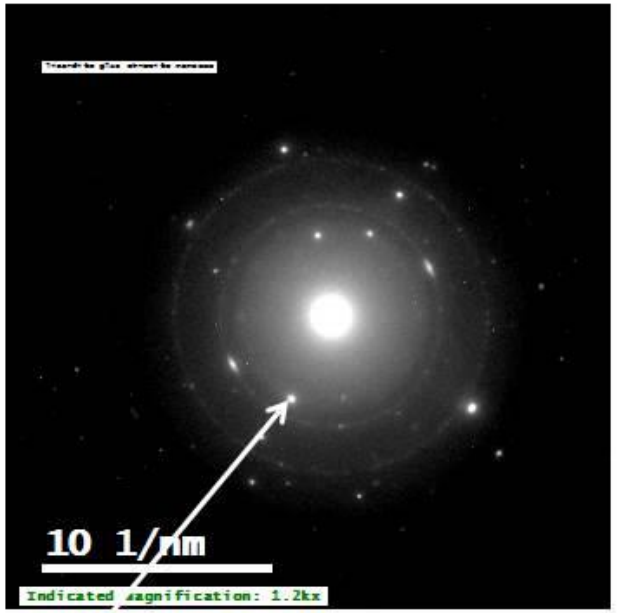
Fig. S4

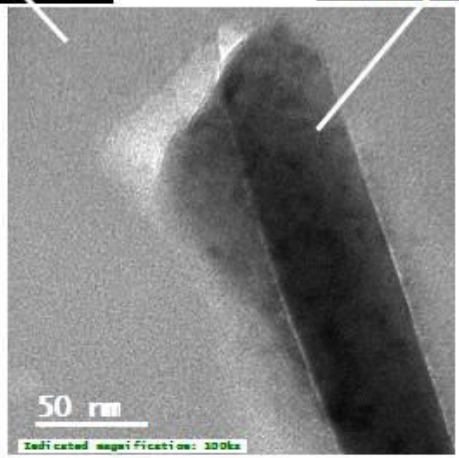
TEM images and SAED pattern of treated sample

Fig.S5



Amorphous silica





Clinochlore
Diffractions spots
d= 2.7 (114)
d= 2.45 (132)
d= 1.63 (137)
d= 1.36 (139)

Chromite nanoparticles
Diffraction rings
d= 2.06 (400)chr
d=1.46 (440)chr

Chromitite from the Mistake mine, California, USA

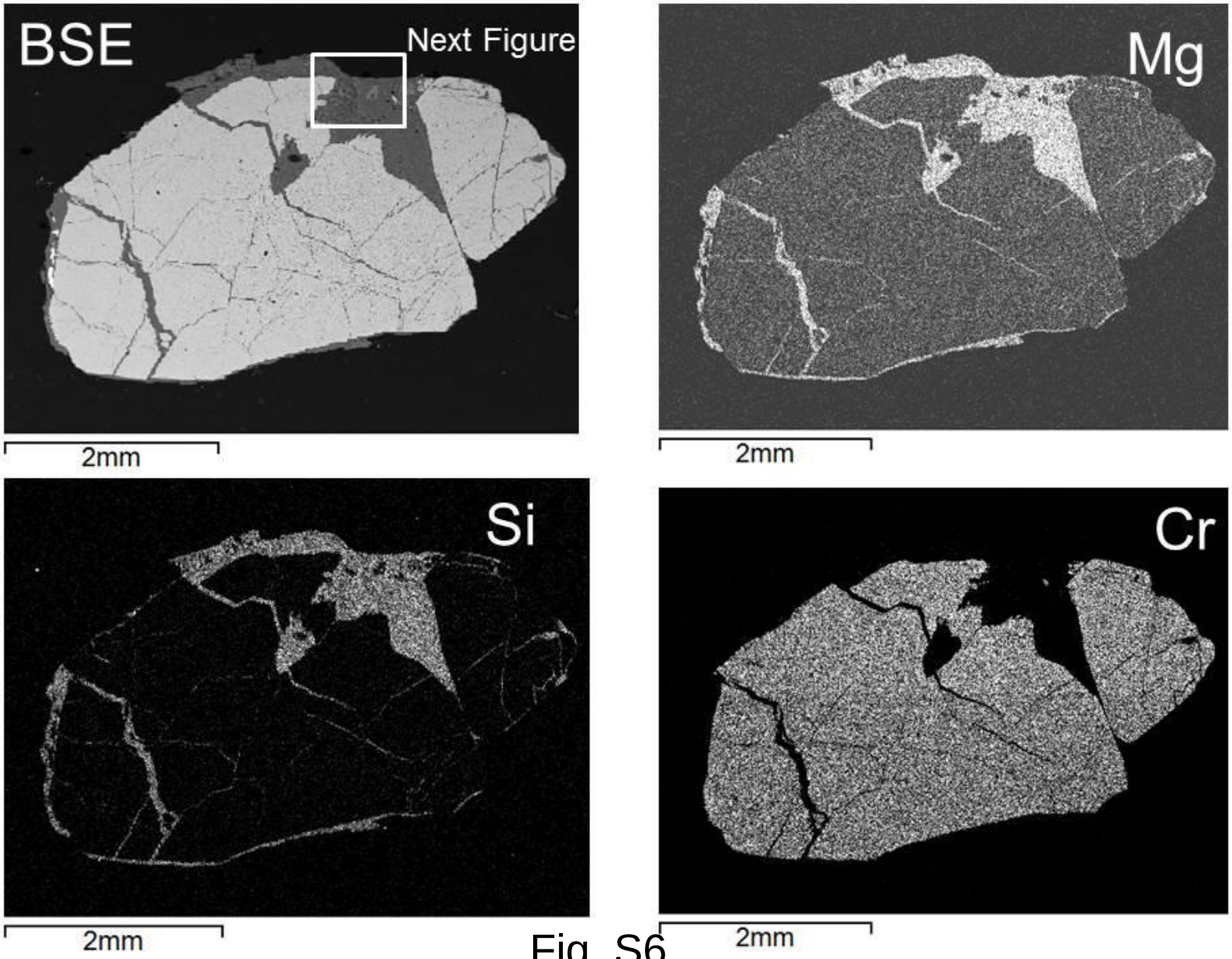


Fig. S6

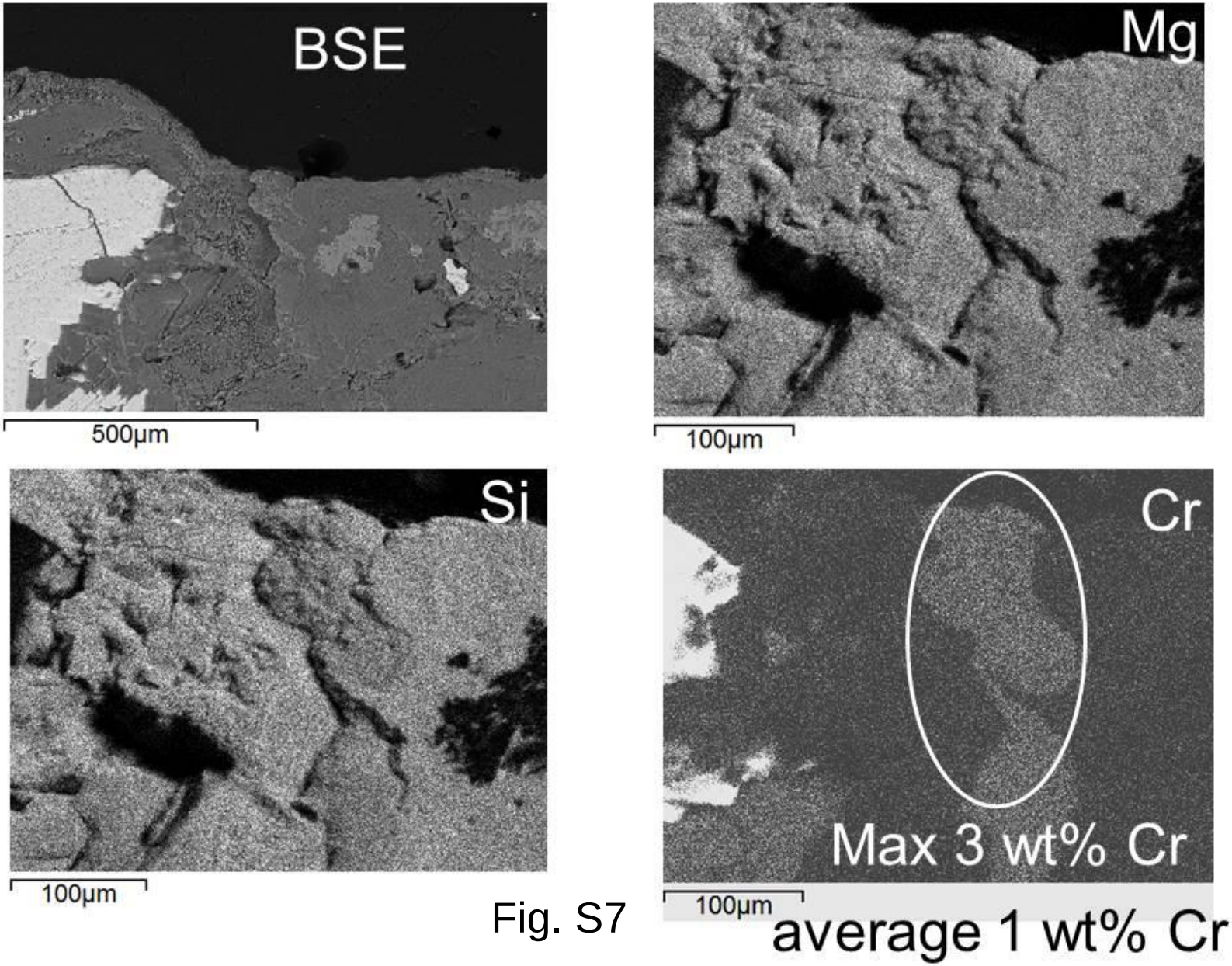
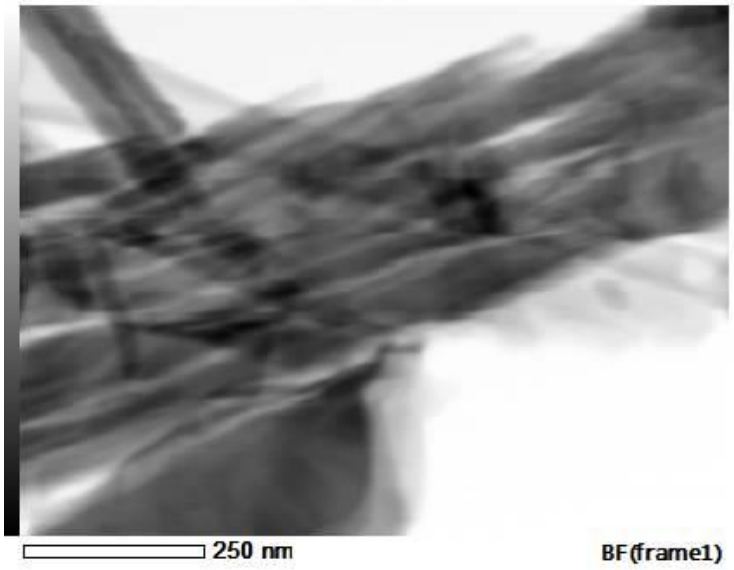
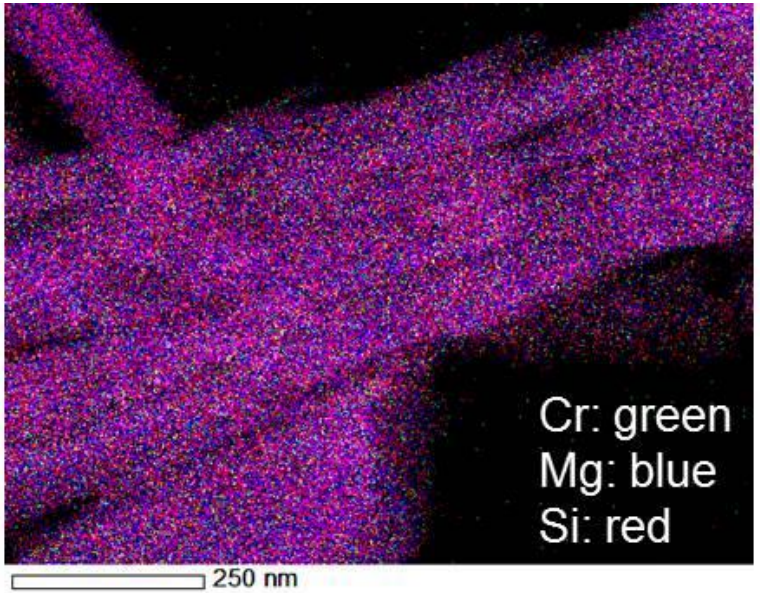
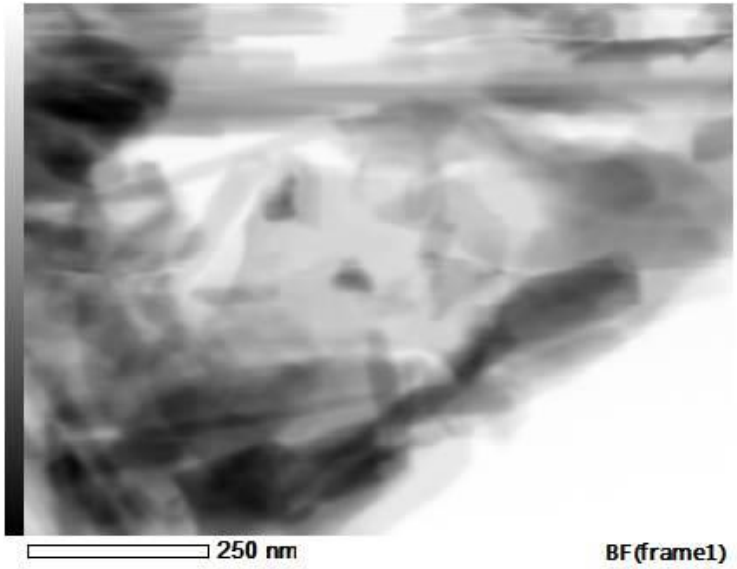


Fig. S7


250 nm
BF(frame1)


Cr: green
Mg: blue
Si: red
250 nm


250 nm
BF(frame1)

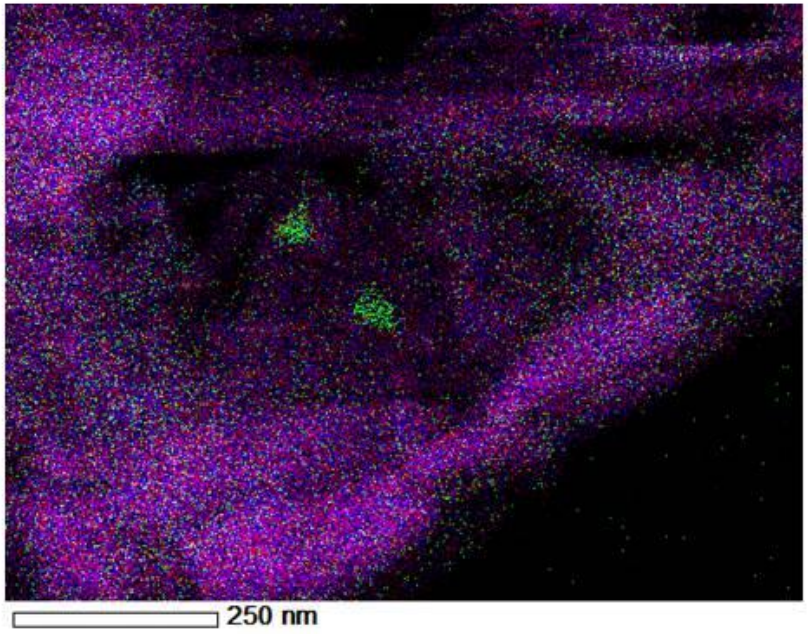
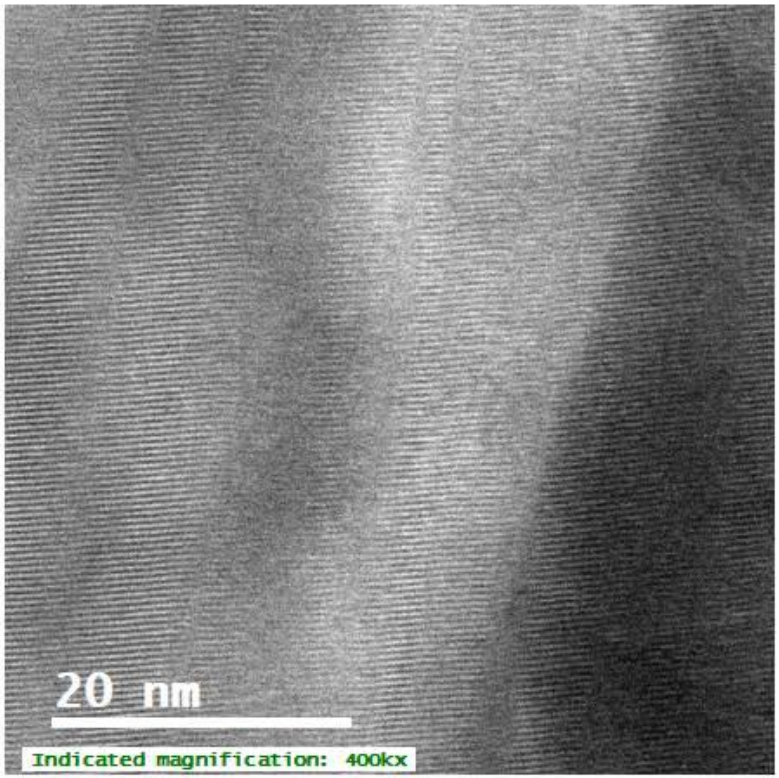
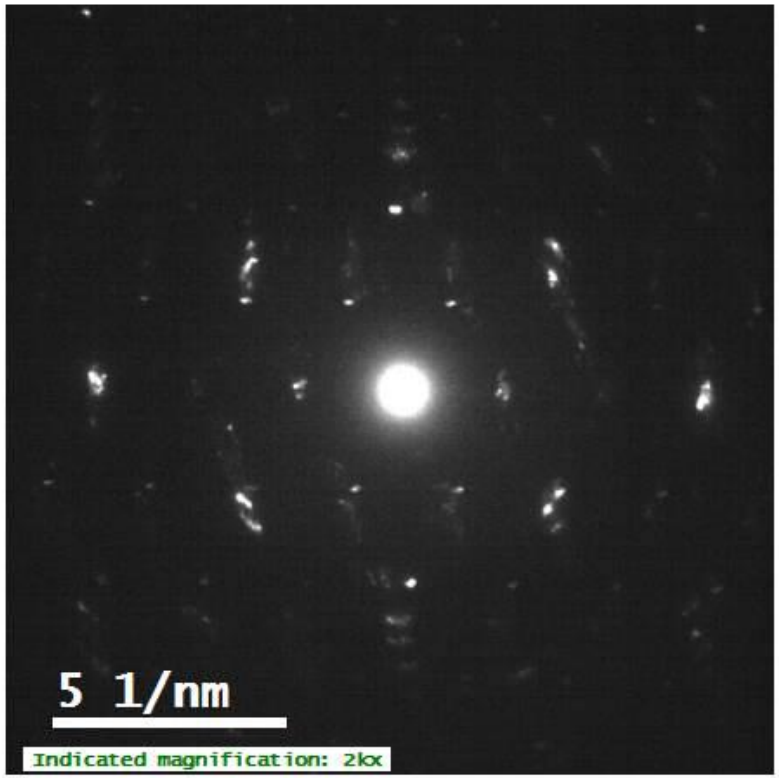

250 nm

Fig. S8

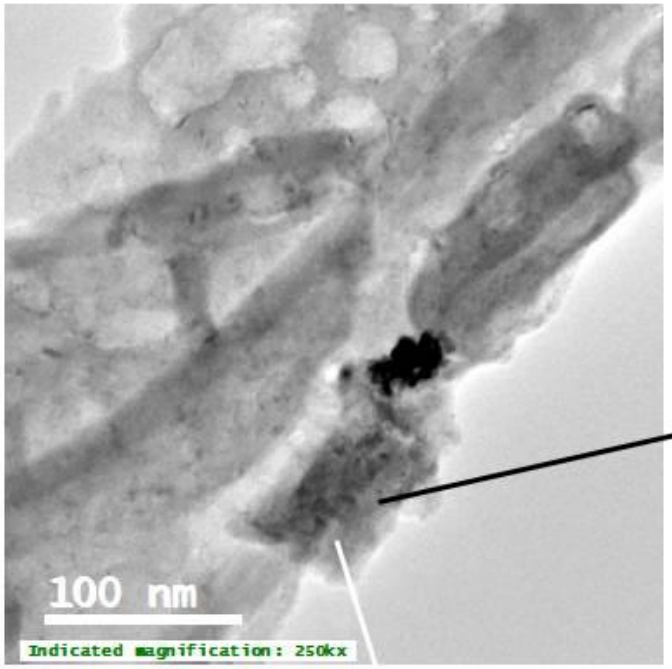


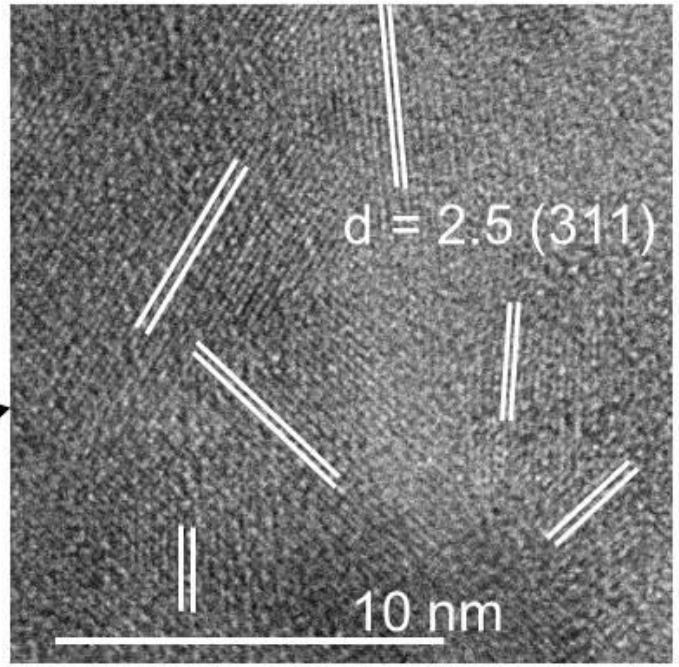
Lizardite matrix without chromite nanoparticles

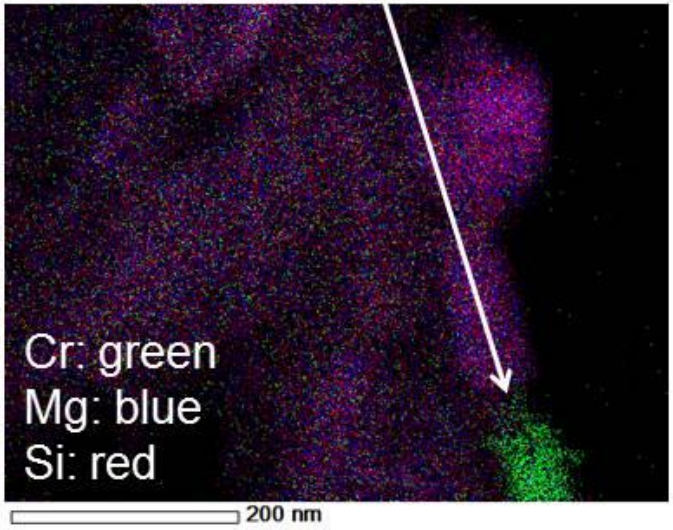


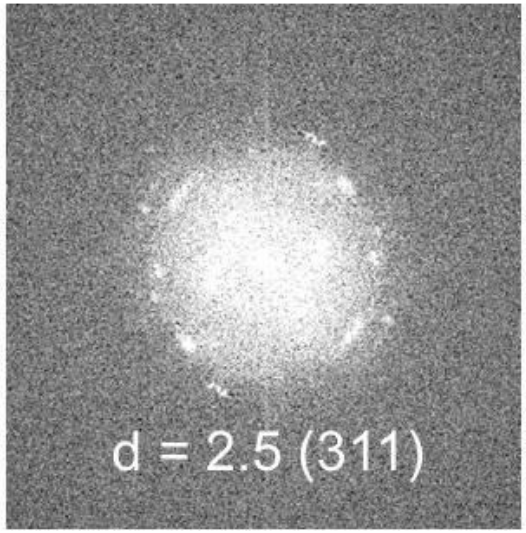
Lizardite SAED
d = 4.6 (100), 4.3 (101), 2.5 (105), 2.4 (006)

Fig. S9









Aggregated Chromite nanoparticles

Fig.S10

FFT pattern