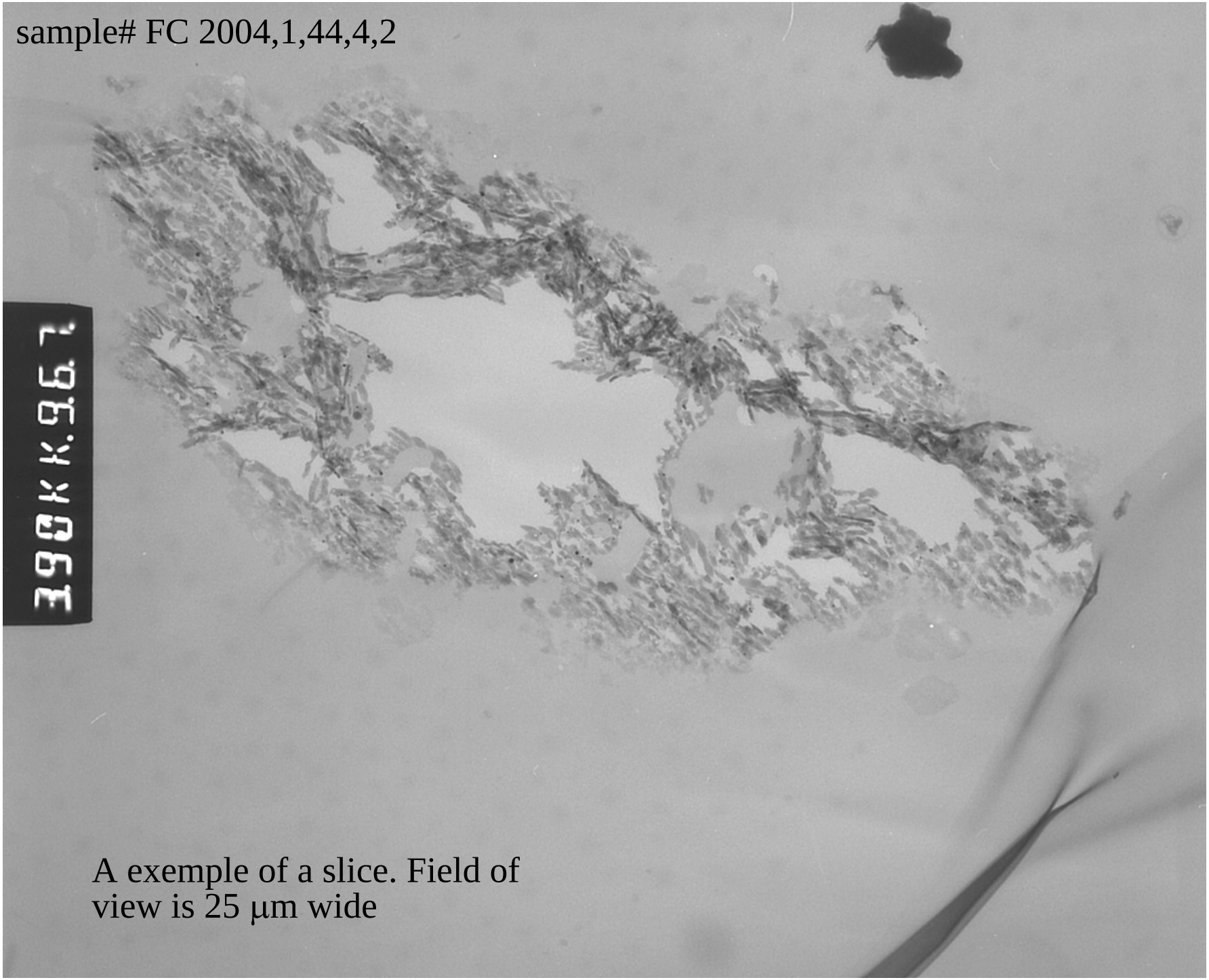
Lille, April, 2006
Stardust, sample# FC 2004,1,44,4,2
H. Leroux and M. Gounelle, who were helped by P. Cordier, D. Jacob, C. Davoisne
Done with a Philips CM30 and a FEI Tecnai G20

The sample consist mostly of an amorphous silica-rich matrice with numerous small metal droplets. This matrix contains also low and variable amount of Mg, Al, Ca. It is a mixing between melted aerogel and a melted cometary grain. The metal droplets are cristalline. Sulfur is found associated with metal but is found mainly within the silicate. The sample is probably a quenched impact melt, with evidence for silicate-metal immiscibility.

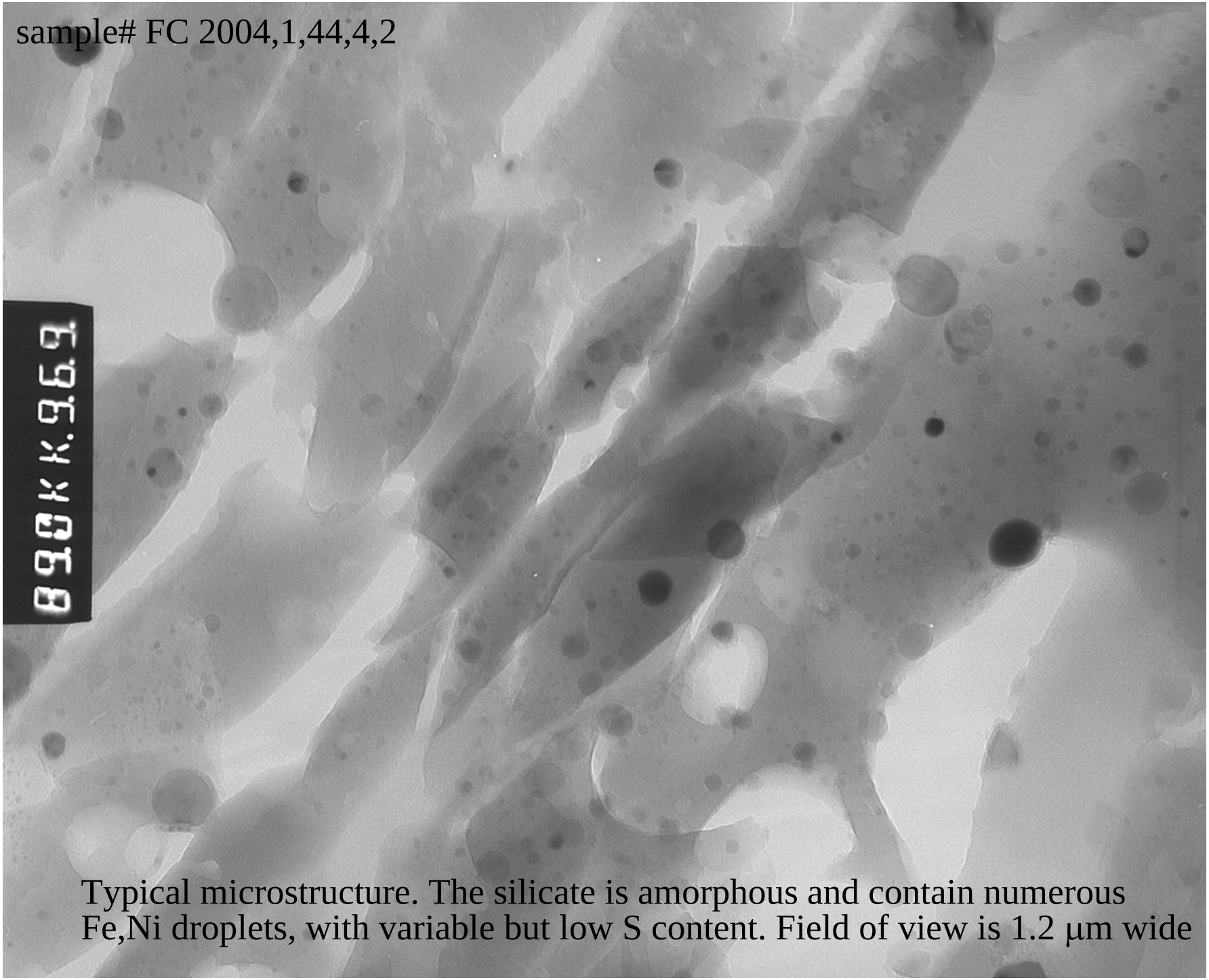
Some sulfide crystalline grains are present. They seem to be non-stoichiometric, with an excess of S. Diffraction compatible with pyrrhotite. Other are metallic Si and metallic Al, which are probably contaminants.

Some photos, analyses and elemental distributions are shown in the following.

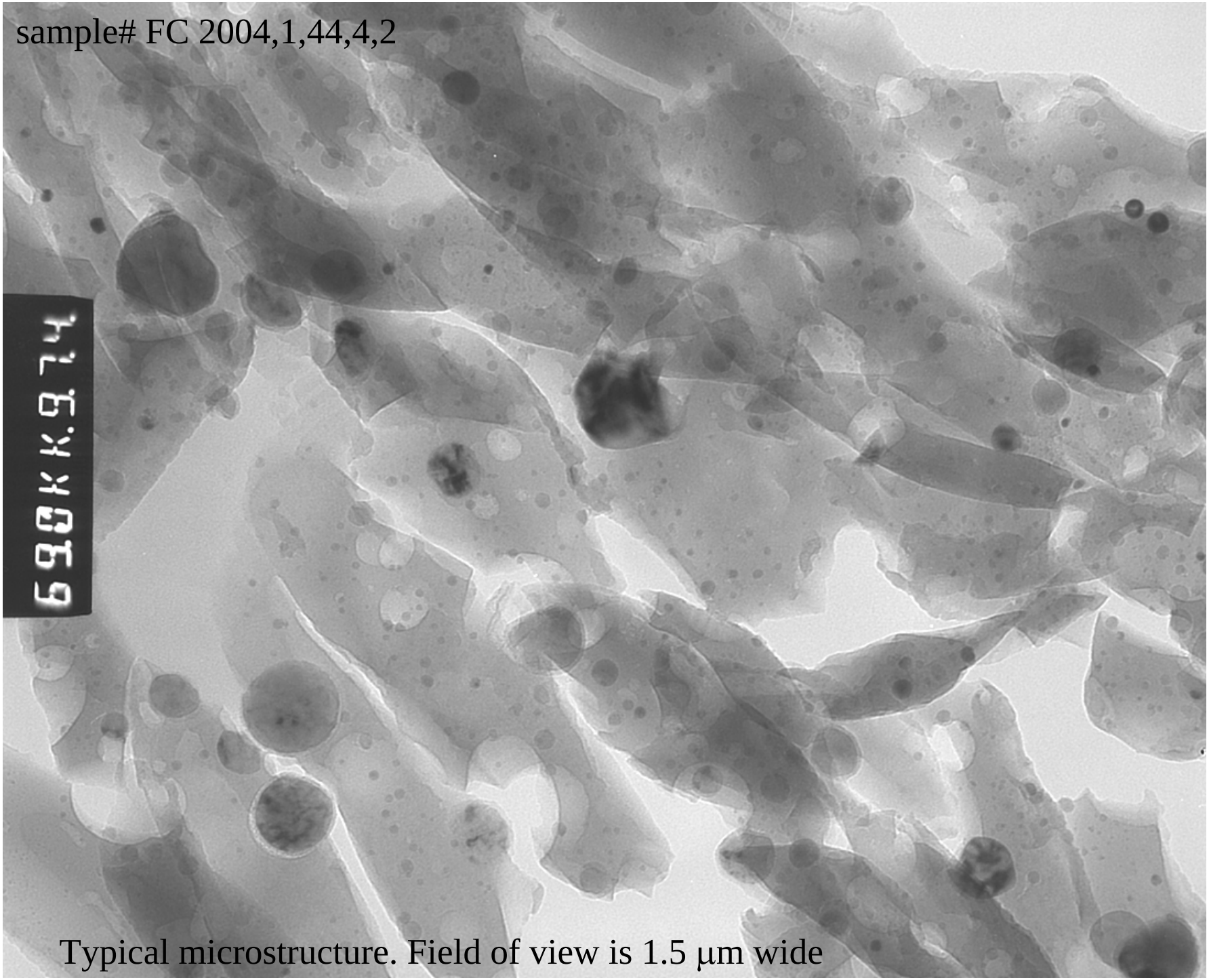
sample# FC 2004,1,44,4,2



A exemple of a slice. Field of view is 25 μm wide



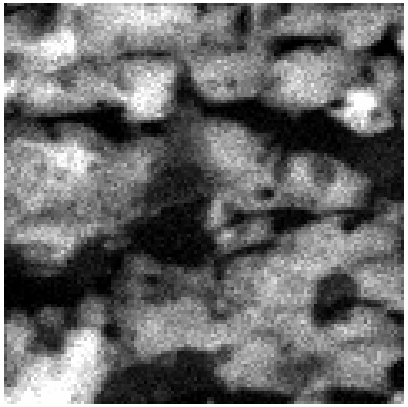
Typical microstructure. The silicate is amorphous and contain numerous Fe,Ni droplets, with variable but low S content. Field of view is 1.2 μm wide



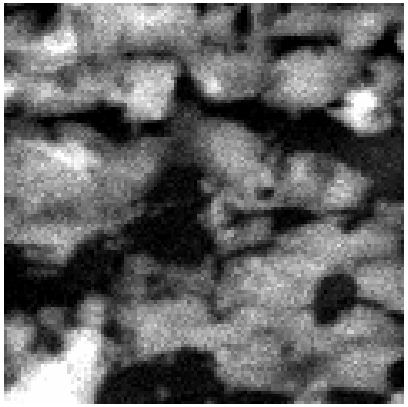
Typical microstructure. Field of view is 1.5 μm wide

sample# FC 2004,1,44,4,2

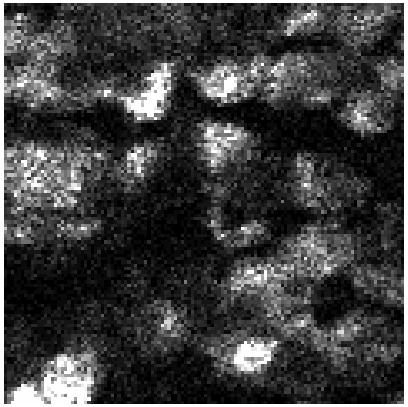
Elemental distribution



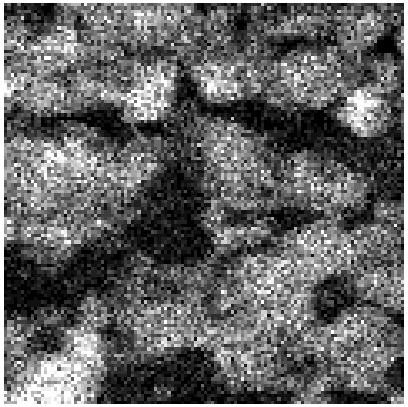
O



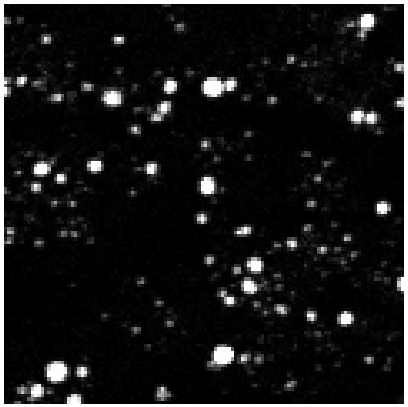
Si



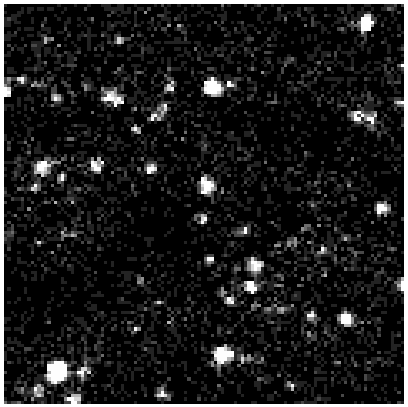
Mg



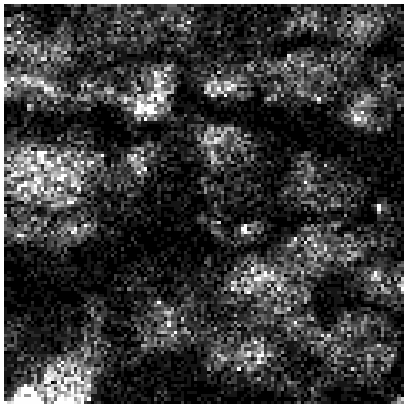
Al



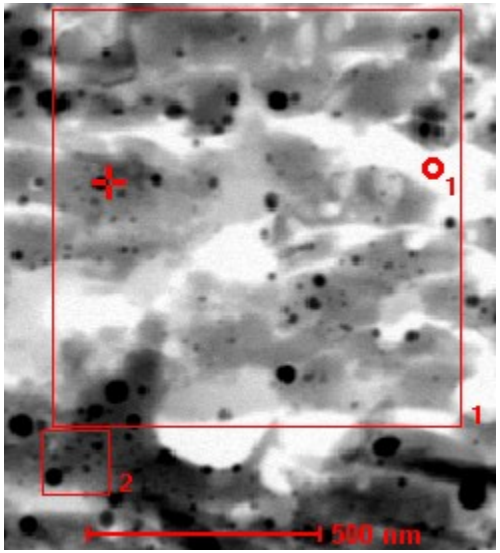
Fe



Ni

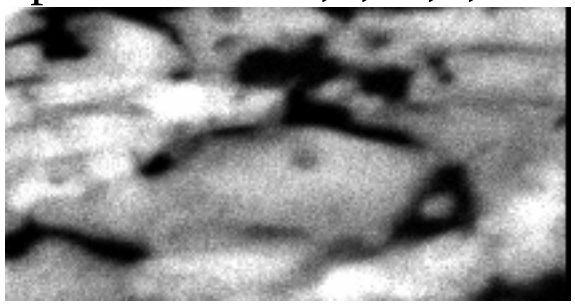


S

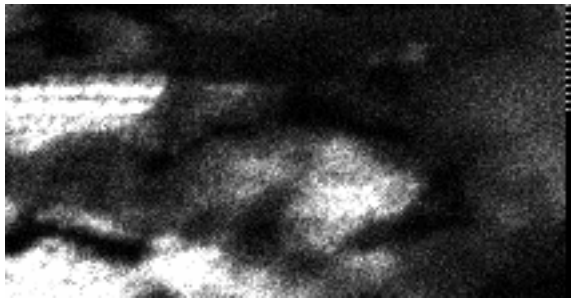


Note the heterogeneous distribution of Mg (relative to Si). Note that S is not strongly associated with Fe.

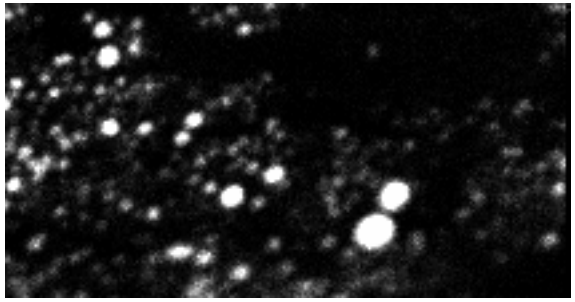
sample# FC 2004,1,44,4,2



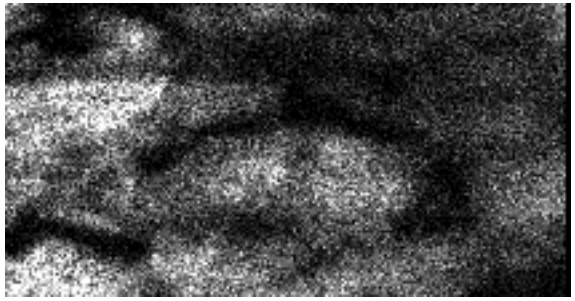
Si



Mg



Fe

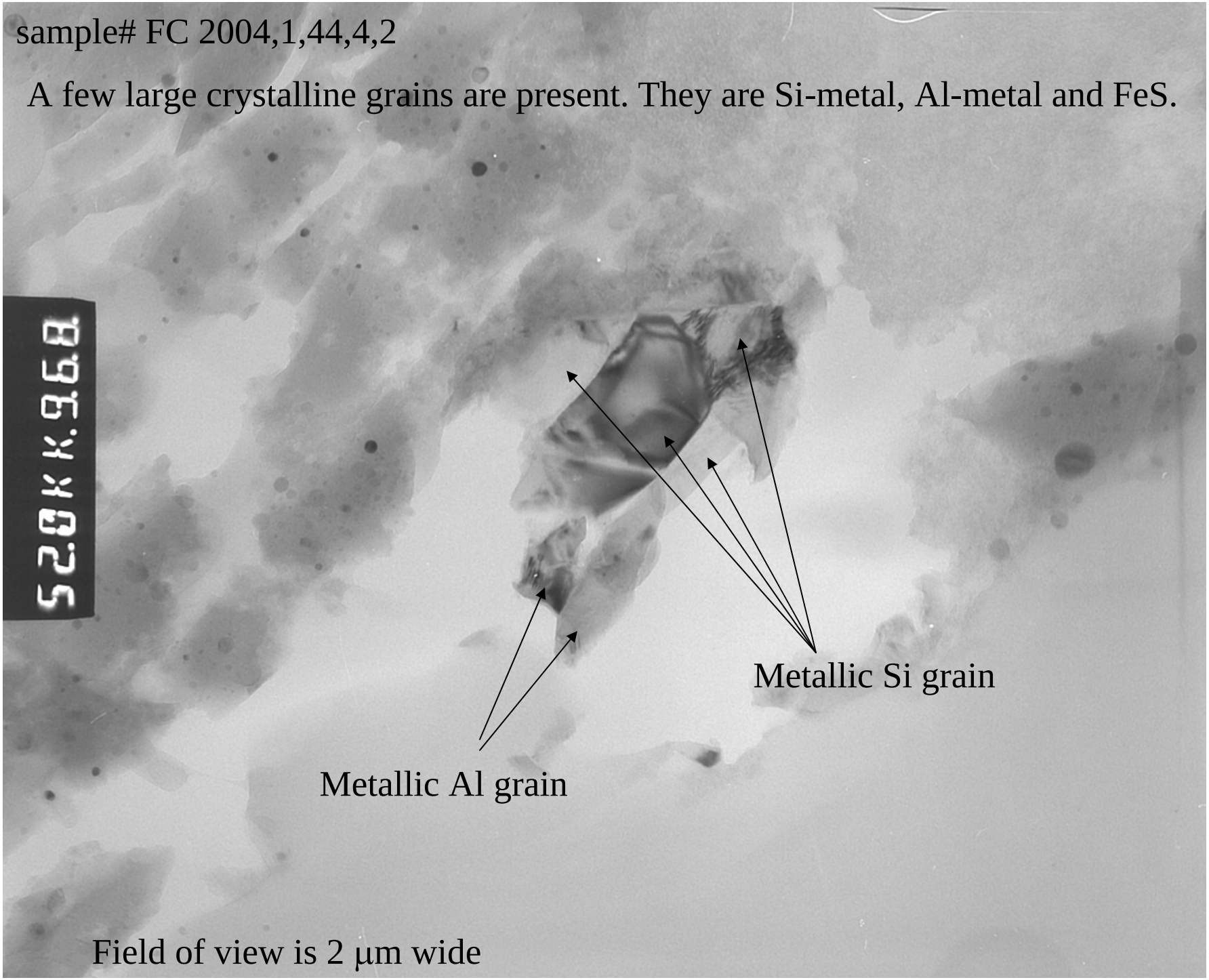


S

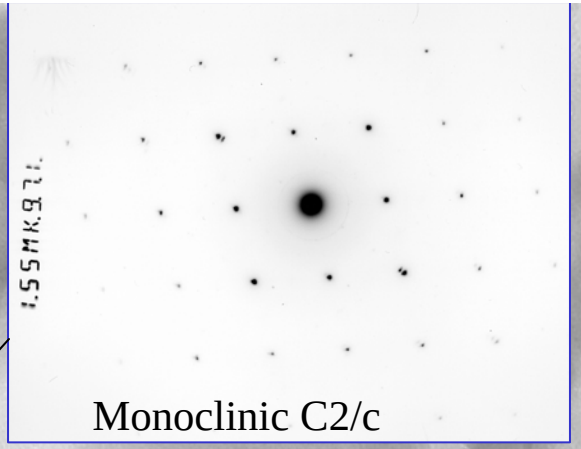
Other elemental distribution. Note the heterogeneous distribution of Mg (relative to Si). Note that S is not strongly associated with Fe.

sample# FC 2004,1,44,4,2

A few large crystalline grains are present. They are Si-metal, Al-metal and FeS.



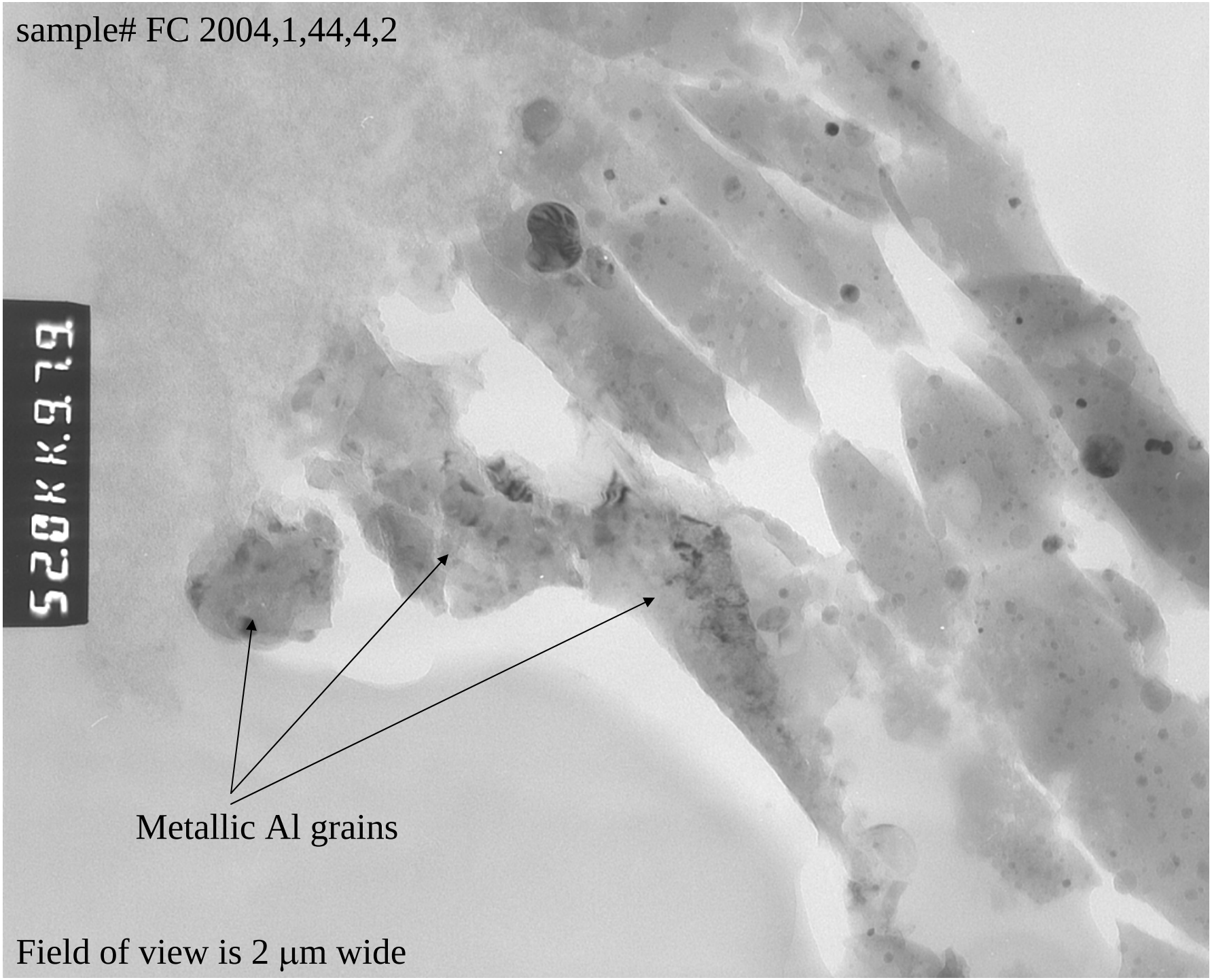
sample# FC 2004,1,44,4,2



Monoclinic C2/c
d=0.270 nm for the two directions
[-2,2,4] + [-2,-2,4] = [-4,0,8] ; angles are OK

Fe,S grain. The diffraction pattern is compatible with pyrrhotite

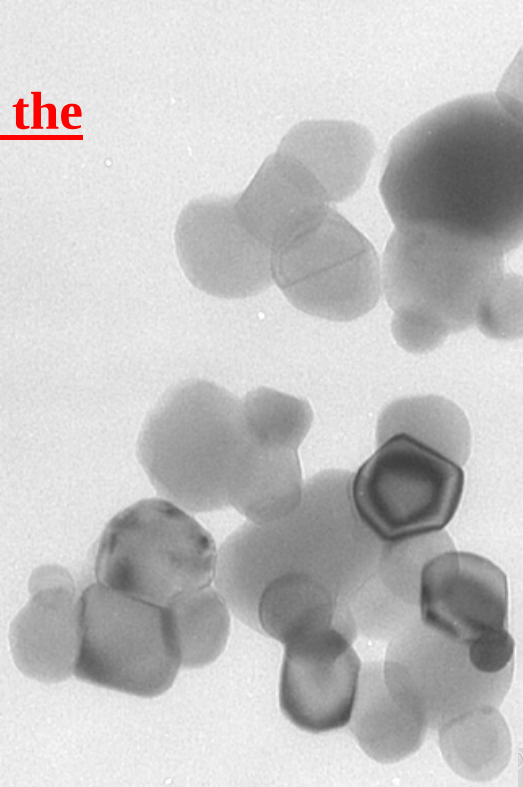
Field of view is 1.1 μm wide

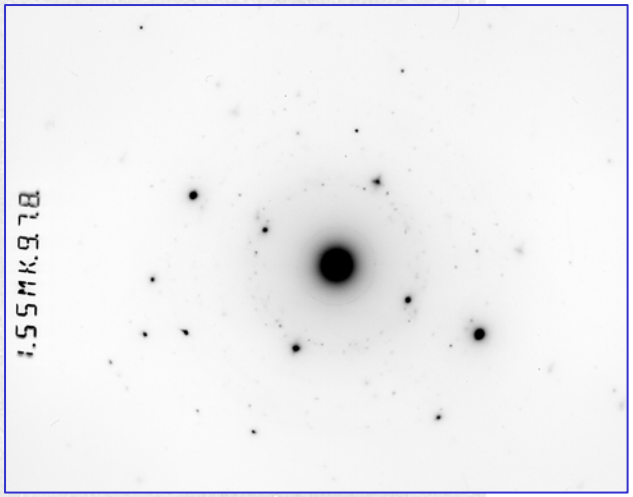

sample# FC 2004,1,44,4,2
520X 61 6X 025
Metallic Al grains
Field of view is 2 μm wide

sample# FC 2004,1,44,4,2

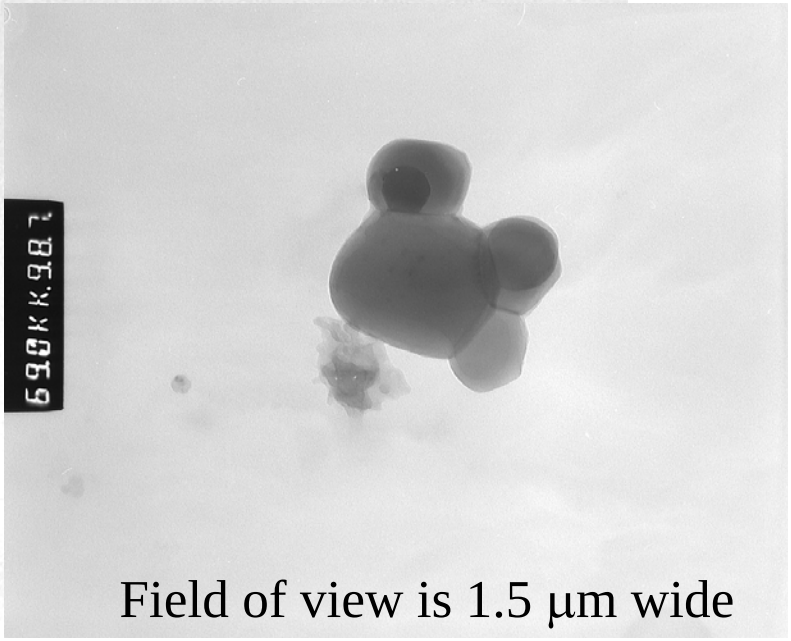
Other particles found **out of the slices** (no relation with the sample)

TiO_2 particle





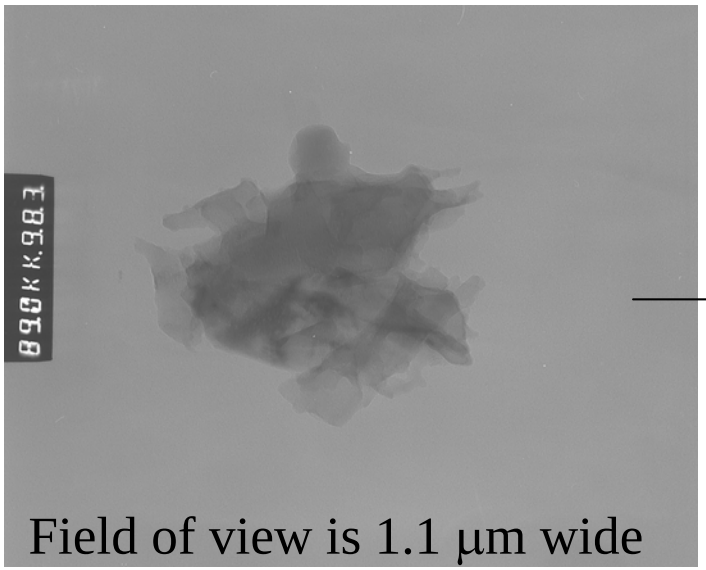
Field of view is 2 μm wide



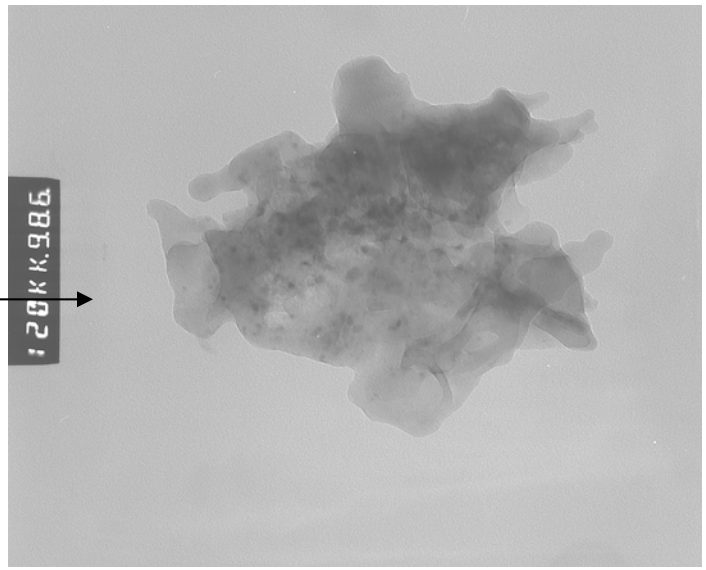
Field of view is 1.5 μm wide

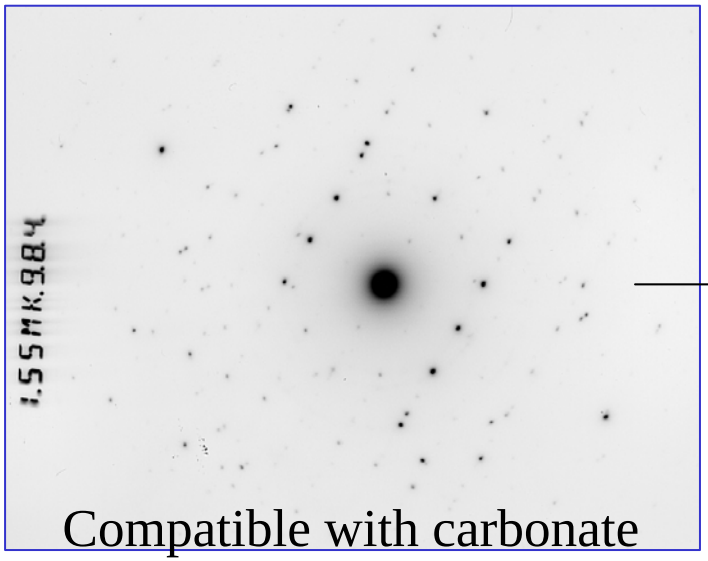
sample# FC 2004,1,44,4,2

A carbonate grain, **out of the slices**. Under irradiation it progressively converts into CaO, according to the decarbonatation reaction $CaCO_3 = CaO + CO_2$

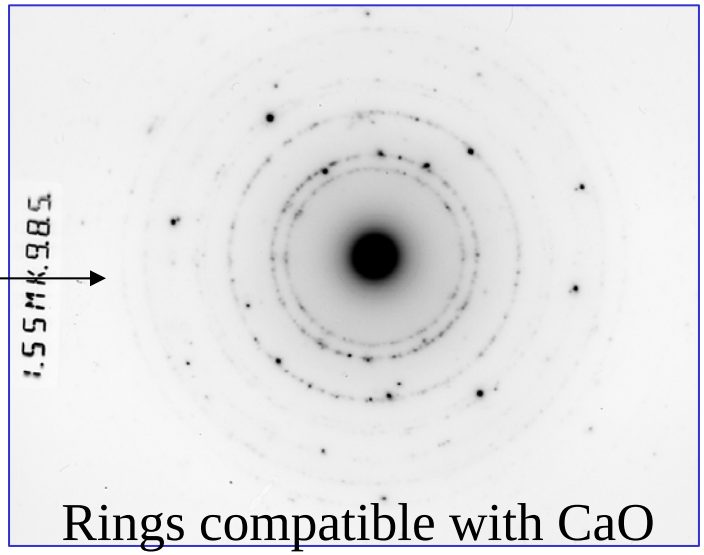


Field of view is 1.1 μm wide





Compatible with carbonate



Rings compatible with CaO

sample# FC 2004,1,44,4,2

spe	Fe	Ni	S
148	96.8	3.2	nd
154	87.1	5.0	8.0
156	92.4	5.8	1.8
157	91.6	5.9	2.5
159	44.8	0.02	55.2
160	48.2	0.04	51.8
165	94.6	4.9	0.5
166	41.5	0.09	58.4
167	97.2	6.2	6.6
169	96.7	2.6	0.6
170	92.5	5.9	1.6
171	93.0	3.3	3.7
175	47.7	0.02	52.2
176	92.5	5.1	2.4
177	92.8	4.9	2.3

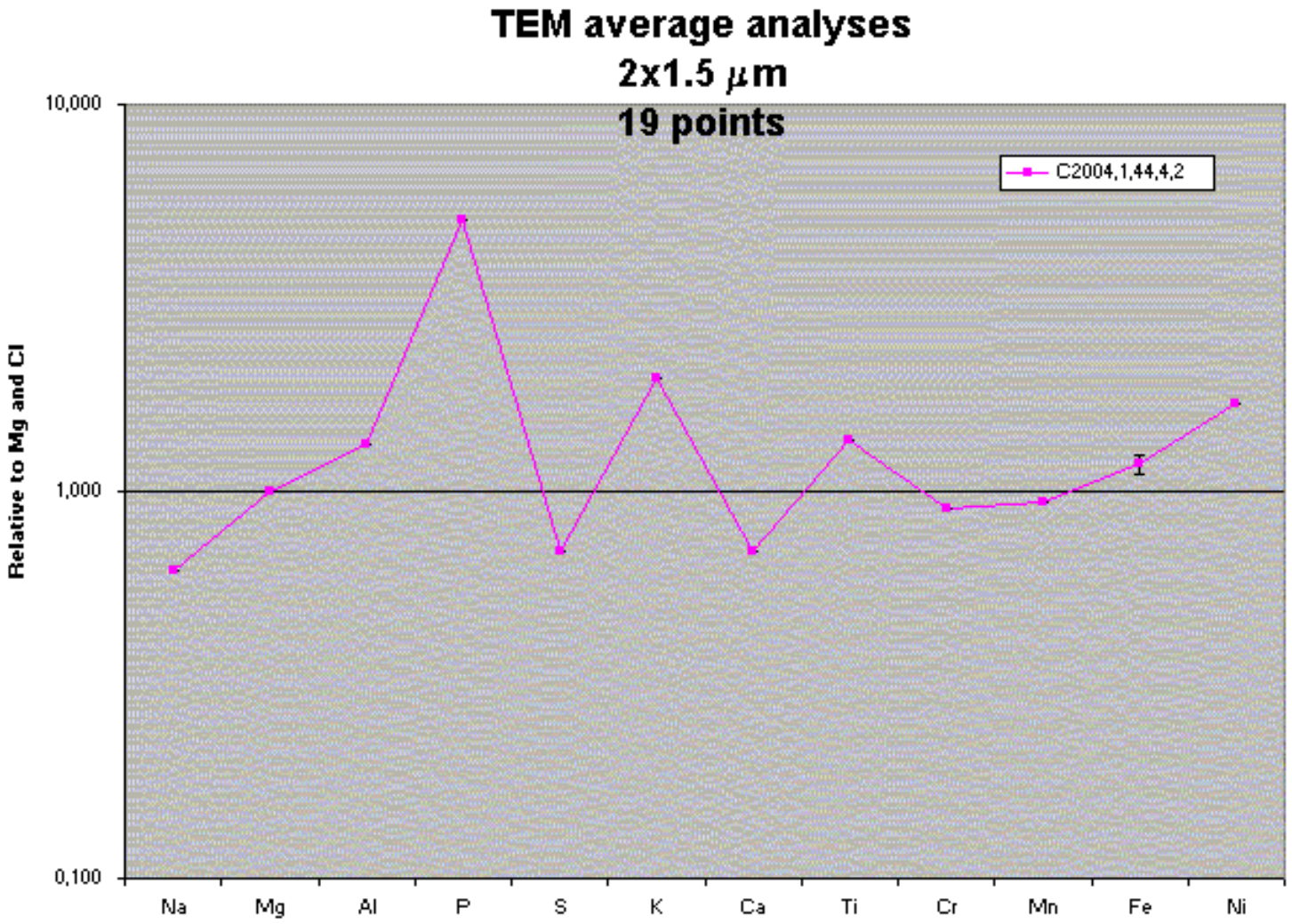
Analyses of Fe-Ni-S droplets

C2004,1,44,4,2 - scanned area: 2*1.5 μm

Long duration analysis (typically 300 sec, up to 1000 sec) of the impact melt
Data in at% (Oxygen is not shown)
CM30 Philips – Noran-Vantage

Spe	Si	Mg	Fe	Ni	S	Al	Ca	K	Ti	Cr	Mn	Na	P
210	29.2	3.5	0.93	0.02	0.69	0.62	0.18	0.02	0.02	0.03	0.05	0.13	0.04
211	29.6	2.9	2.4	0.17	0.87	0.34	0.12	0	0.02	0.04	0.04	0.05	0.07
212	31.2	1.1	1.3	0.06	0.65	0.12	0.03	0	0.03	0.07	0	0	0.06
213	29.0	2.6	2.2	0.15	0.85	0.29	0.11	0.02	0	0.02	0.04	0.10	0.08
214	26.9	3.5	5.2	0.31	1.1	0.24	0.15	0.02	0	0.03	0.05	0.06	0.10
215	29.2	2.4	2.1	0.16	0.67	0.19	0.08	0	0.02	0.02	0.02	0.11	0.08
216	28.6	2.6	6.4	0.53	0.65	0.18	0.11	0	0	0.04	0.02	0	0.18
217	31.1	2.5	1.1	0.08	0.60	0.23	0.07	0.01	0.01	0.01	0.03	0.07	0.06
218	28.9	3.0	1.6	0.07	0.79	0.33	0.14	0.02	0	0.03	0	0.04	0.07
219	31.4	1.7	1.5	0.42	0.56	0.66	0.08	0.03	0.01	0.02	0.02	0	0.12
220	31.3	1.8	2.4	0.17	0.69	0.20	0.13	0	0	0.02	0.02	0.05	0.18
221	30.7	1.9	1.6	0.09	0.70	0.20	0.09	0	0	0	0	0.10	0.07
222	27.5	6.0	1.9	0.09	1.2	0.40	0.20	0.03	0.01	0.04	0.03	0.03	0.03
223	28.7	3.5	4.8	0.38	0.52	0.08	0.06	0.06	0	0.03	0	0.15	0.20
224	31.0	2.2	2.1	0.12	0.77	0.16	0.09	0	0	0.03	0.02	0.13	0.05
225	31.0	2.1	0.6	0.11	0.70	0.30	0.10	0.02	0	0.03	0.02	0.11	0.04
226	29.3	2.2	3.4	0.26	0.61	0.11	0.06	0.03	0	0.01	0	0.15	0.08
227	28.2	2.9	3.8	0.25	0.63	0.19	0.09	0.06	0	0.02	0.04	0.09	0.12
228	31.2	1.9	1.4	0.11	0.59	0.07	0.08	0.03	0	0	0.02	0.23	0.06
229	28.2	3.54	3.10	0.23	0.80	0.25	0.11	0	0	0.05	0.04	0.30	0.07

sample# FC 2004,1,44,4,2



Except for P, the measured value are close to a chondritic composition