Observational possibilities in the middle infrared spectral region

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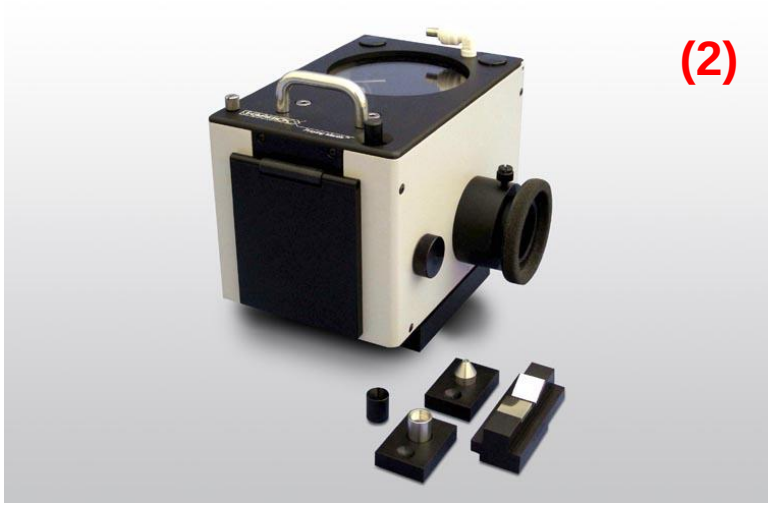
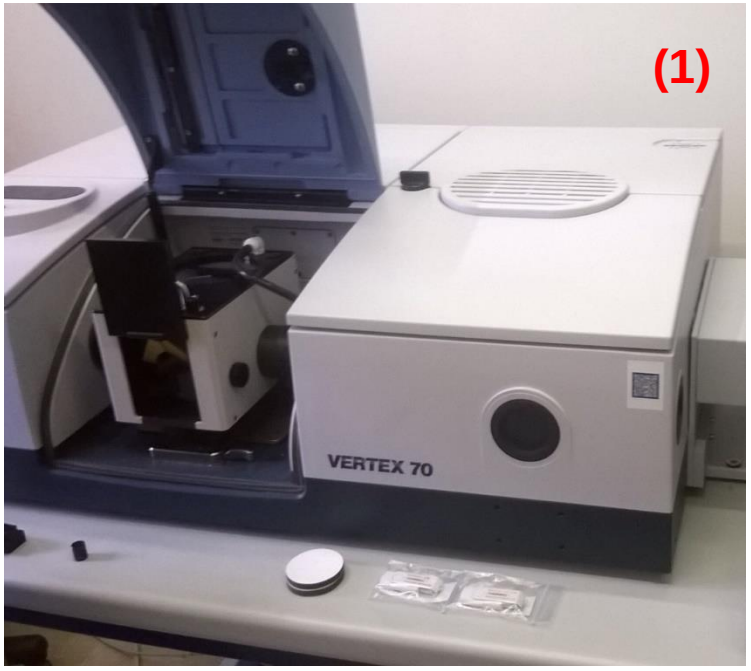
Project overview, aims

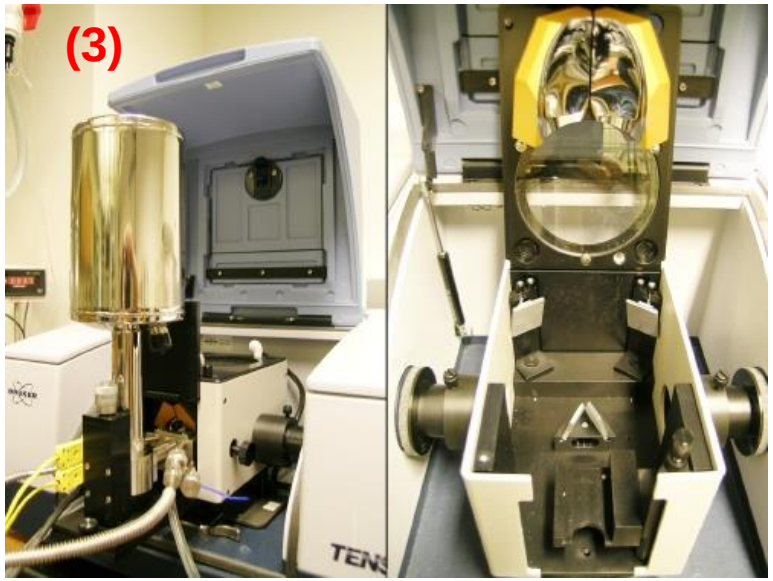
- Hungarian - ESA project (Near Earth Object METeorite LABoratory: NEOMETLAB)
- support thermal infrared camera's (TIRI) definition and development
- optional payload
- by analysing meteorite powders of different
  - grain size, composition
  - shocked properties, mixing ratios
- collaboration with ESA (Kueppers M., Carnelli I., Ulamec S., Ciprianne F.
- what a MIR detector could identify in mineralogy

Methods

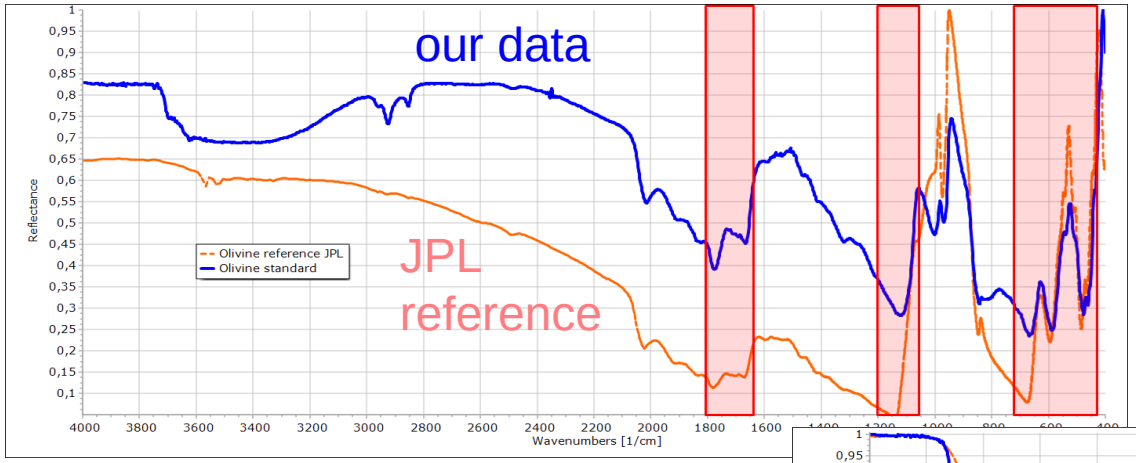
- Vertex 70 Fourier Transform Infrared Spectroscopy **(1)**
- Praying Mantis (Harrick) diffuse reflectance accessory **(2)**
- low temperature reaction chamber **(3)**
- standard minerals
  - <100 µm grain size, room temperature
  - olivine, pyroxene, feldspar
- two meteorites
  - NWA 869 (L4-6)
  - NWA 11469 (CO3)







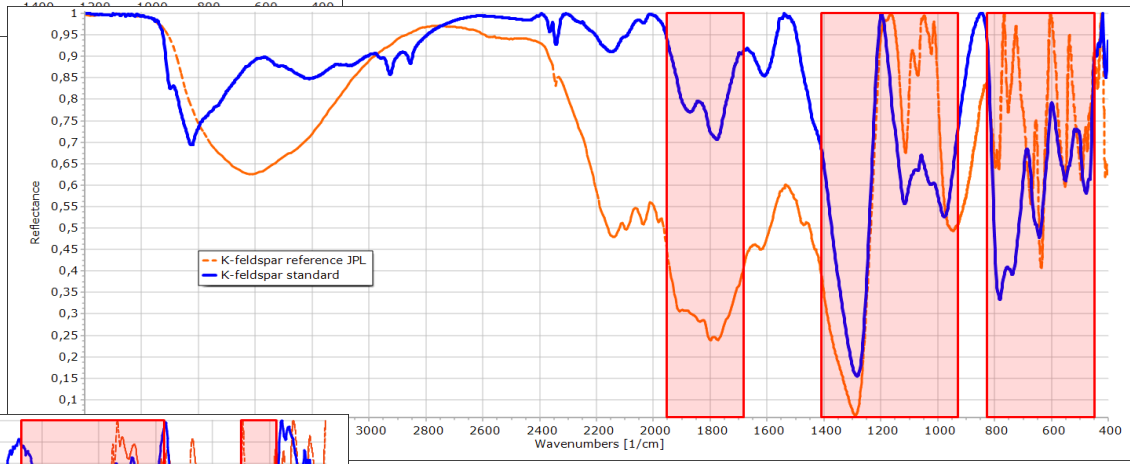
Results – example spectra of standard pure meteorite minerals:

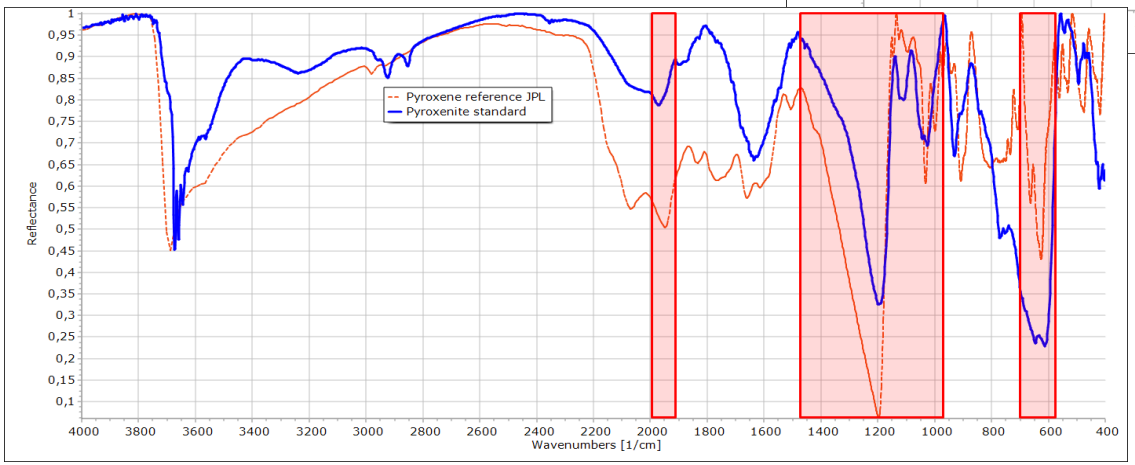


Olivine
Fe,Mg_2SiO_4

key bands for identification

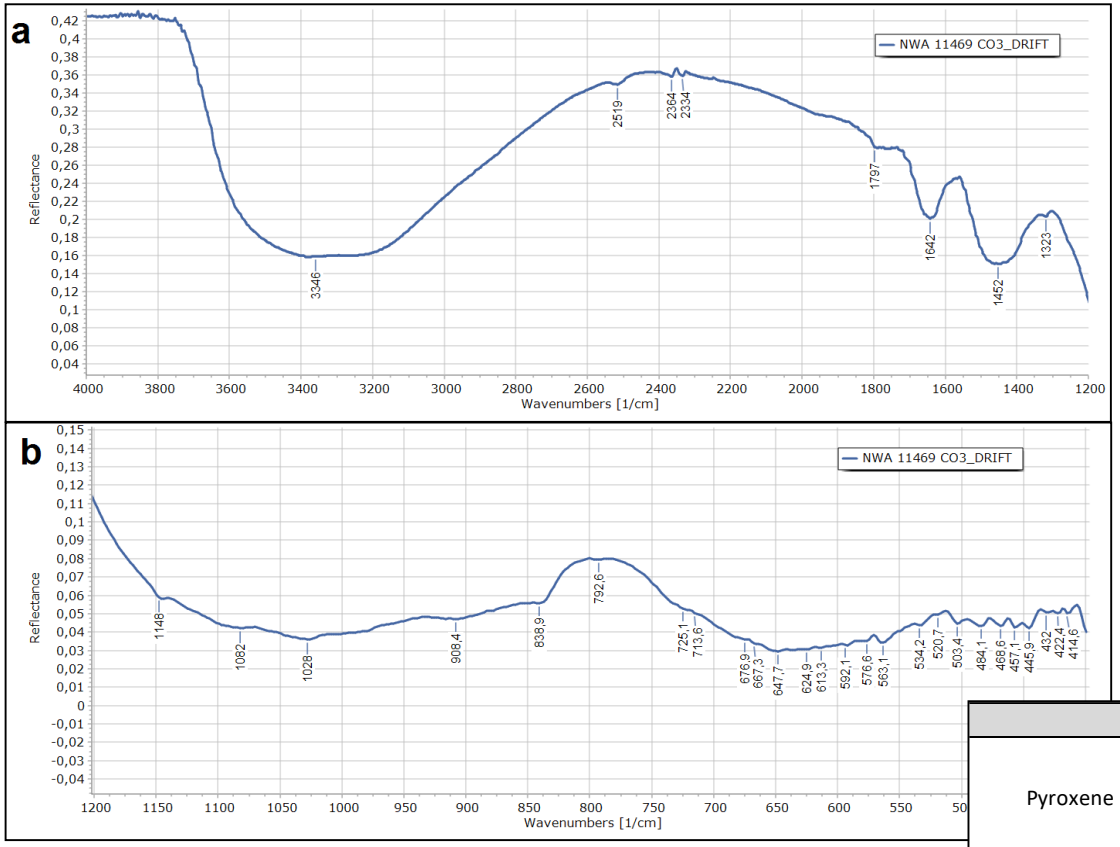
Feldspar
$KAlSi_3O_8$





Pyroxene
$Fe,Mg_2Si_2O_6$

Results – example spectra of meteorite



NWA 869
L 3-6 type
chondrite meteorite

Mineral		DRIFT bands (cm^{-1})
Pyroxene	Enstatite	1023, 970.1, *678.9* , 528.4, 487.9
	Diopside	970.1, 862.1
	Pigeonite	*667.3*
	Augite	
Olivine		*840.9, 613.3, 601.7, 507.2,* 414.6
Spinel		*678.9, 507.2*
Feldspar	K-feldspar	1084, *727.1* , **645.4**, *538.1,* 433.9, 432
	Plagioclase	**925.7**, *727.1* , **645.4**, 563.1, *538.1, 472.3,* 433.9, 432
Clay minerals	Kaolinite	1139, *538.1, 472.3*
	Montmorillonite	916.1, *472.3*
	other	
Carbonate		1445
Troilite		*613.3, 538.1, 455.1*
Iron-oxide	Hematite	*538.1*
	Ilmenite	*538.1,* 441.6
Hydrous iron-oxide		**904.5**, *408.9*
Chromite		**925.7,** *667.3, 408.9*
Kamacite		
Taenite		

Results – role of spectral resolution (cm^{-1}): pure minerals

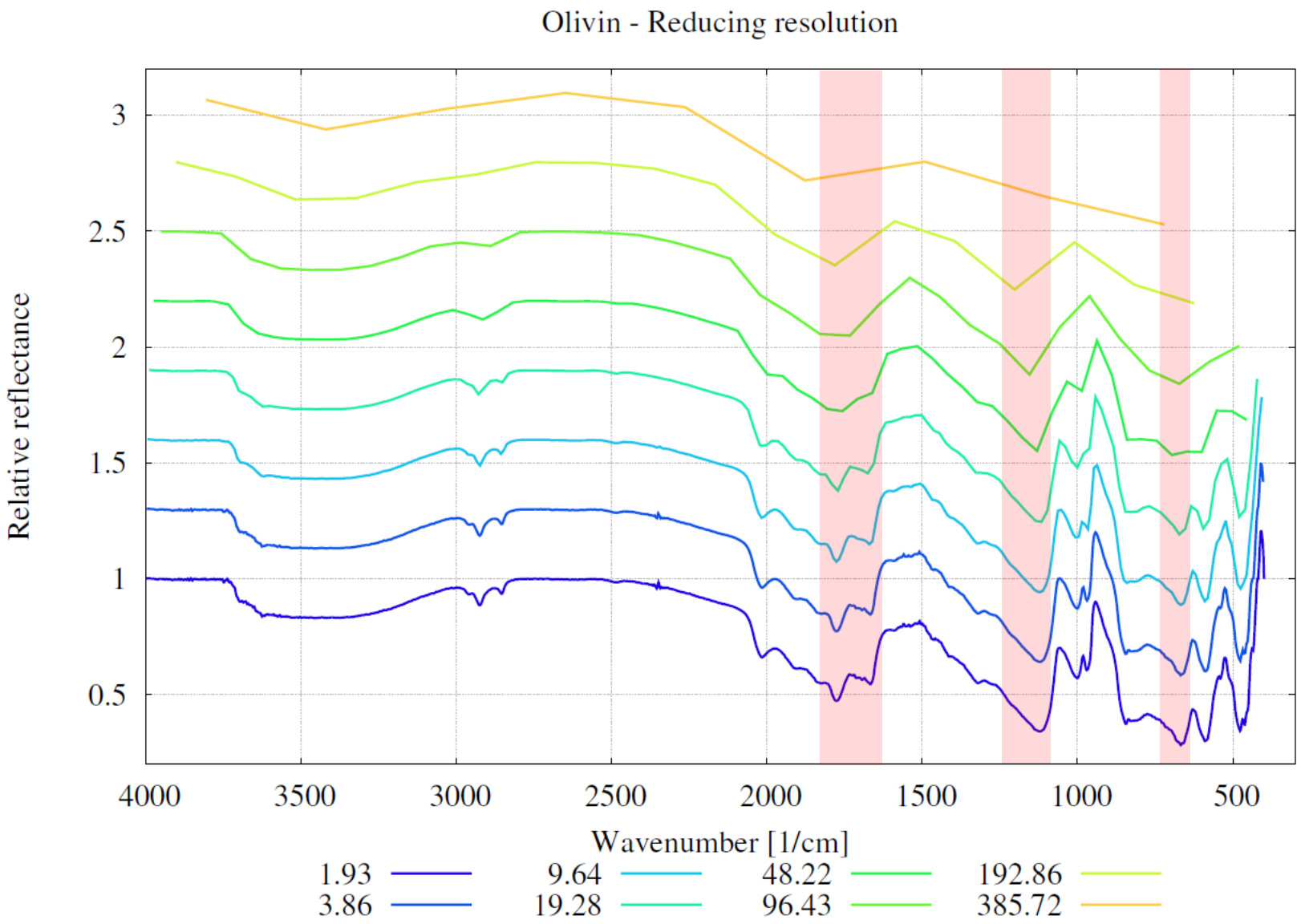
	olivine		
cm-1 res./pos.	1800-1600	1200-1100	700-600
3,9			
9,7			
19,3			
48,3			
96,5			
193,0			
386,0			

	feldspar		
cm-1 res./pos.	1300	1100-900	800-700
3,9			
9,7			
19,3			
48,3			
96,5			
193,0			
386,0			

	evident band, good shape data
	weak band, poor shape data
	uncertain band
	no observable band

	pyroxene		
cm-1 res./pos.	1600-1700	1200	600-700
3,9			
9,7			
19,3			
48,3			
96,5			
193,0			
386,0			

Results – role of spectral resolution (cm^{-1}): pure minerals



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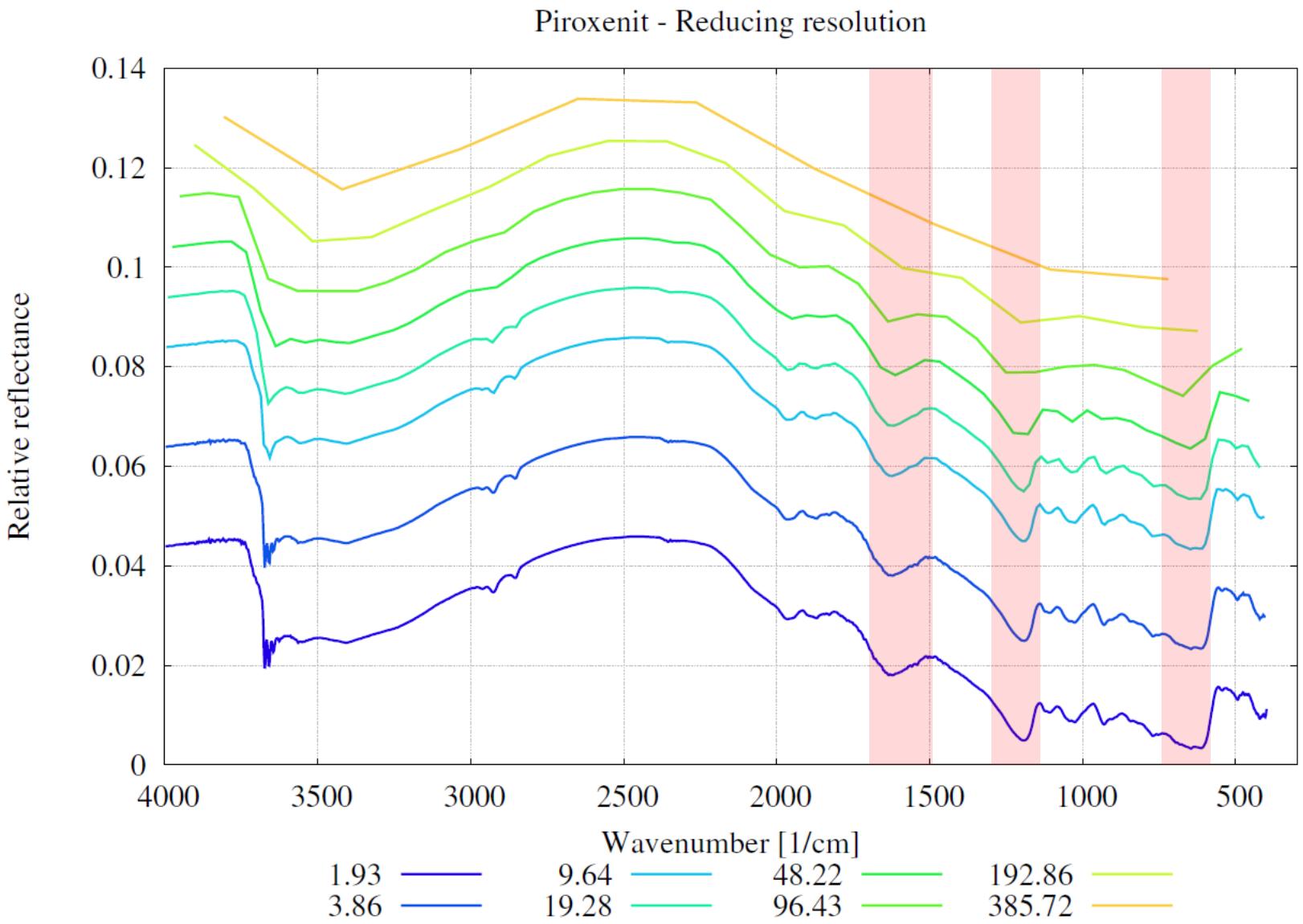
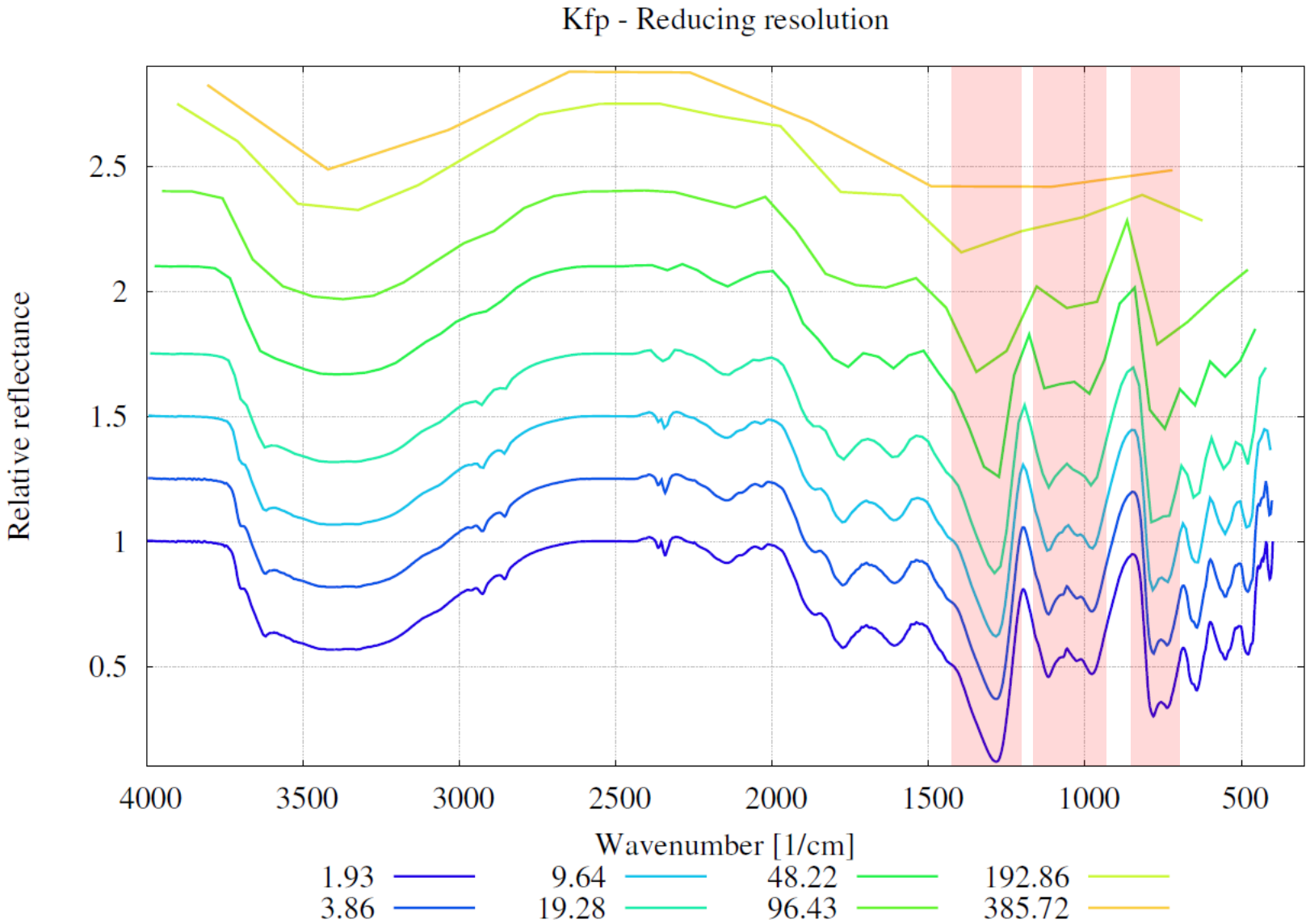


Results – role of spectral resolution (cm^{-1}): pure minerals



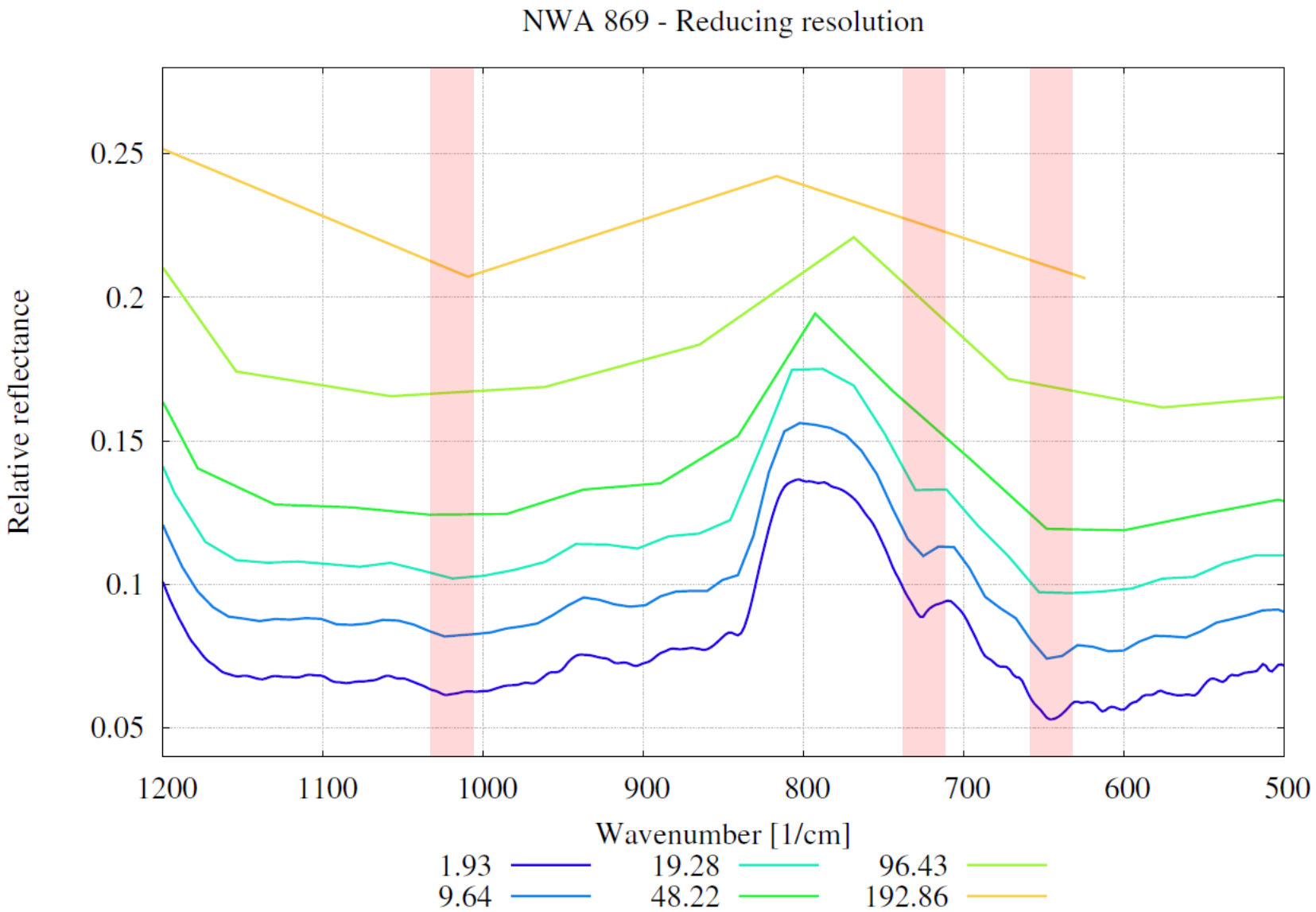
Results – testing changes of spectral resolution: NWA 869

	NWA 869	pyroxene	feldspar	
	cm-1 res./pos.	1023	727	645
2	3,9			
5	9,7			
10	19,3			
25	48,3			
50	96,5			
100	193,0			
200	386,0			

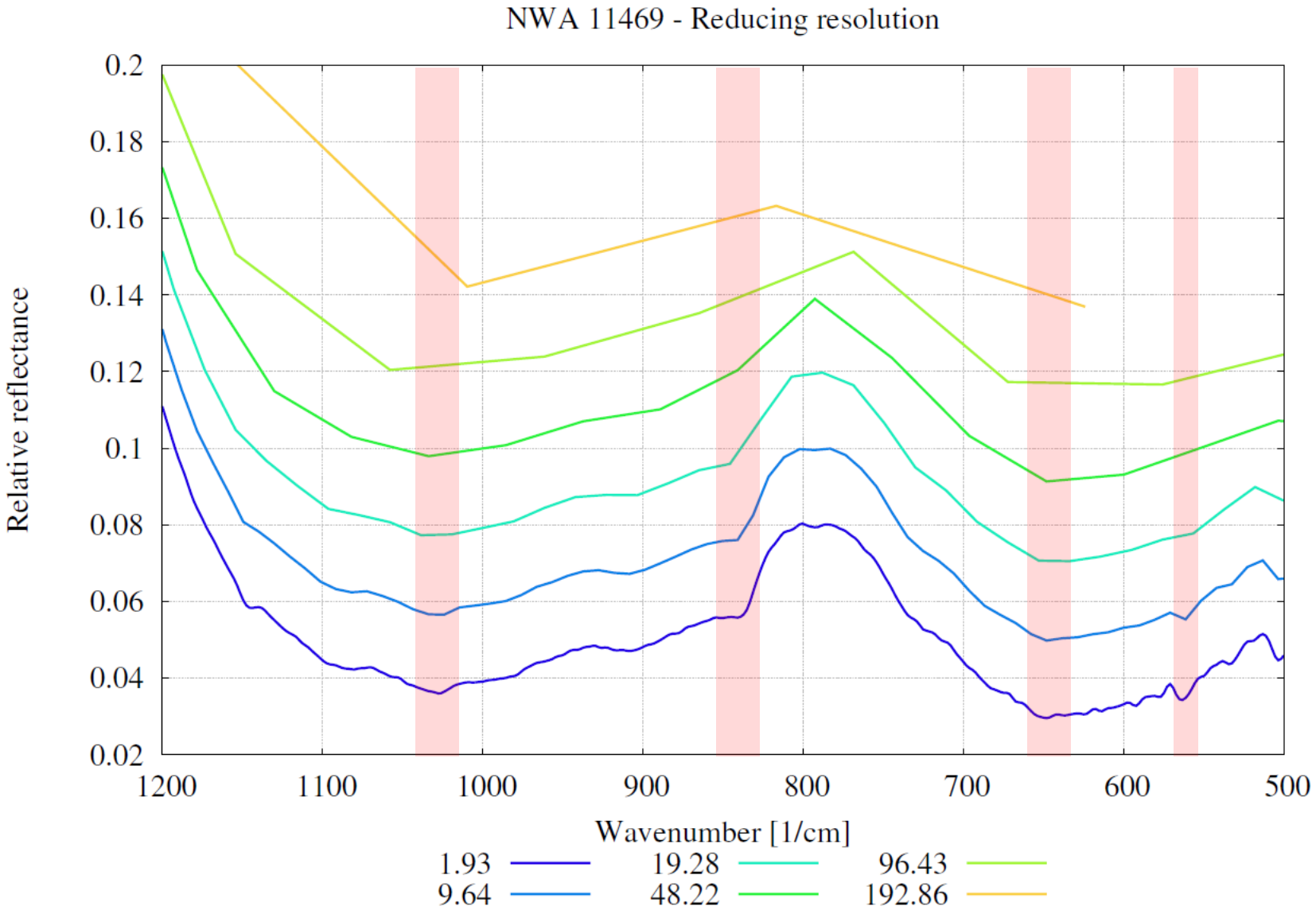
	evident band, good shape data
	weak band, poor shape data
	uncertain band
	no observable band

NWA 11469	pyroxene	kaolinite	feldspar	
cm-1 res./pos.	1028	908	647	563
3,9				
5,8				
9,7				
19,3				
48,3				
96,5	by merged bands			
193,0				
386,0				

Results – testing changes of spectral resolution: NWA 869

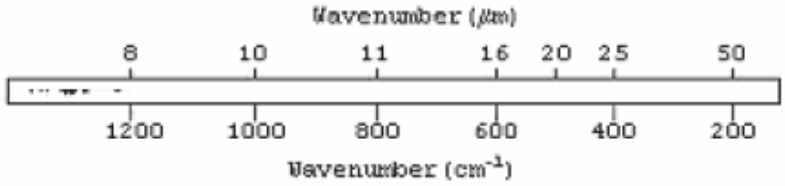


Results – testing changes of spectral resolution: NWA 11469



First conclusions

- surveying equally distributed bands in the MIR
- required spectral resolution
  - for pure standard mineral identification:
    - ol, px, kfp: 200 cm-1 (smaller)
  - for minerals embedded in meteorites:
    - px, kaol, fp 10-20 cm^{-1} (larger)



Expected capabilities:

- better composition analysis
- possible identification of plagioclase
- support for grain size estimation
- geological evolution…

Outlook

- meteorites in 2018-2019
- ideal band positions (not only equally distributed positions)
- implement effect of artificial irradiation (space weathering)

Searching for instrument related technical collaborators!