



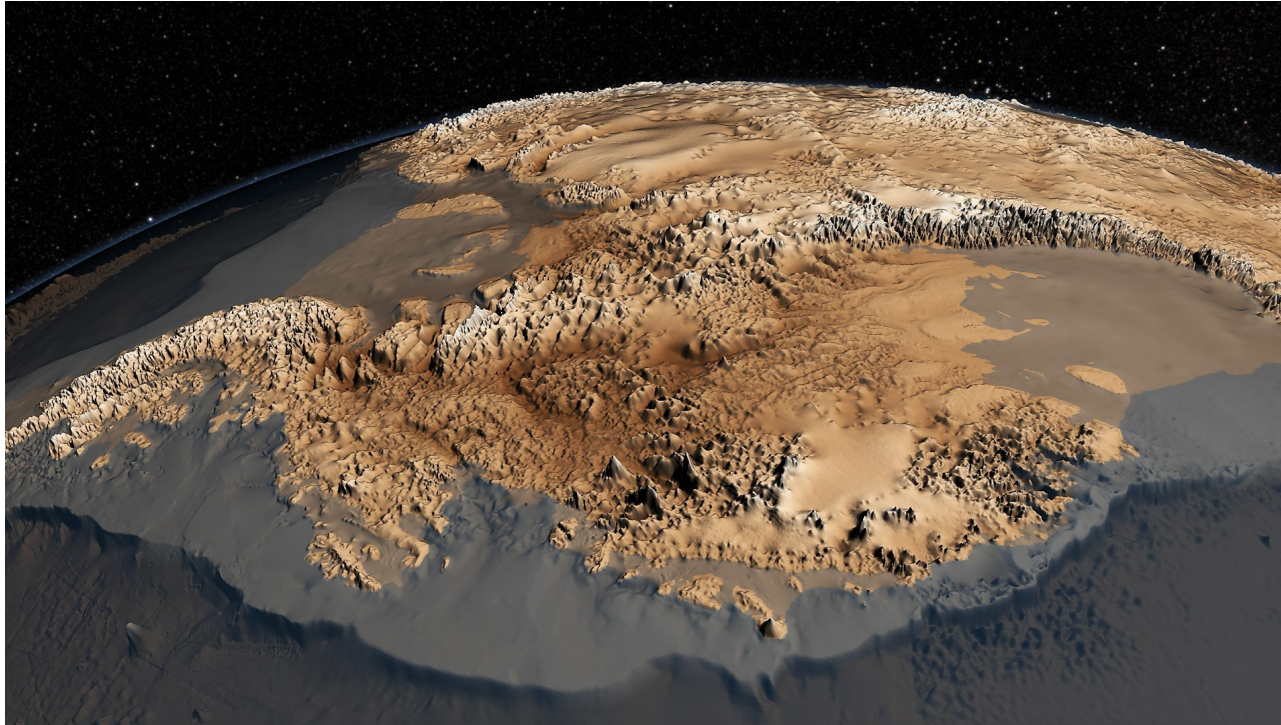
Geology in the Polar regions

Polar Symposium 2022

Steven Goderis - Vrije Universiteit Brussel



- Antarctica & Arctic regions = **extremely varied**, with **fossiliferous** sedimentary rocks, **magmatic** rocks, a wide range of **metamorphic** rocks, as well as active volcanoes and glacial deposits.
- Inferred from the limited exposed areas (roughly 0.4% of Antarctica) + **remote sensing techniques**
- Close **interaction** between geosphere, cryosphere, hydrosphere and atmosphere
- **Mineral resources** and **meteorites** (protected by the Antarctic Treaty)

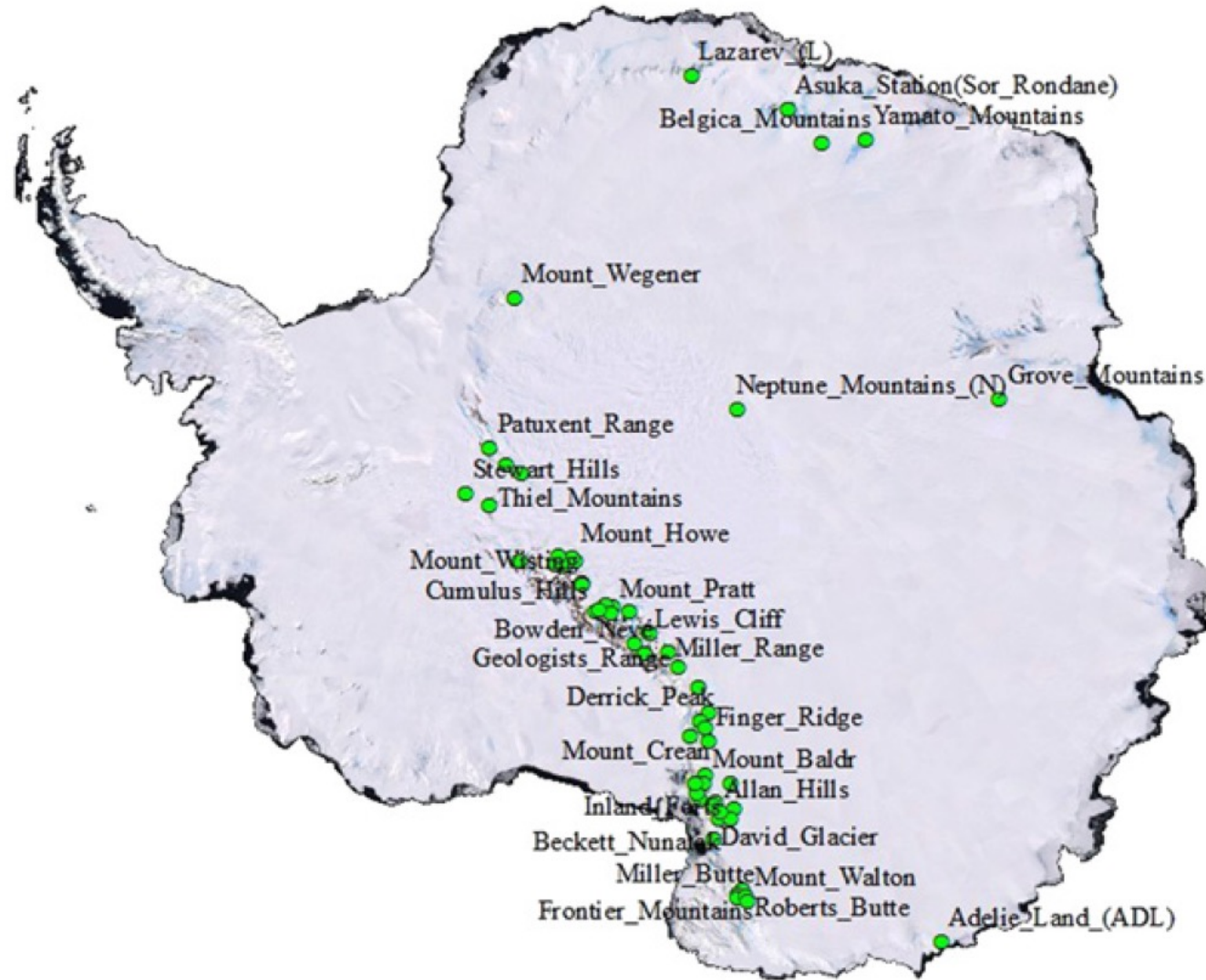
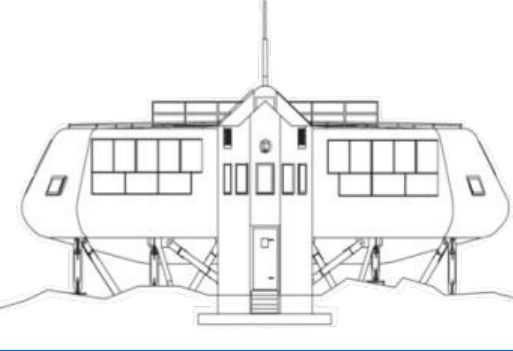


Bedrock topography of Antarctica (NASA)



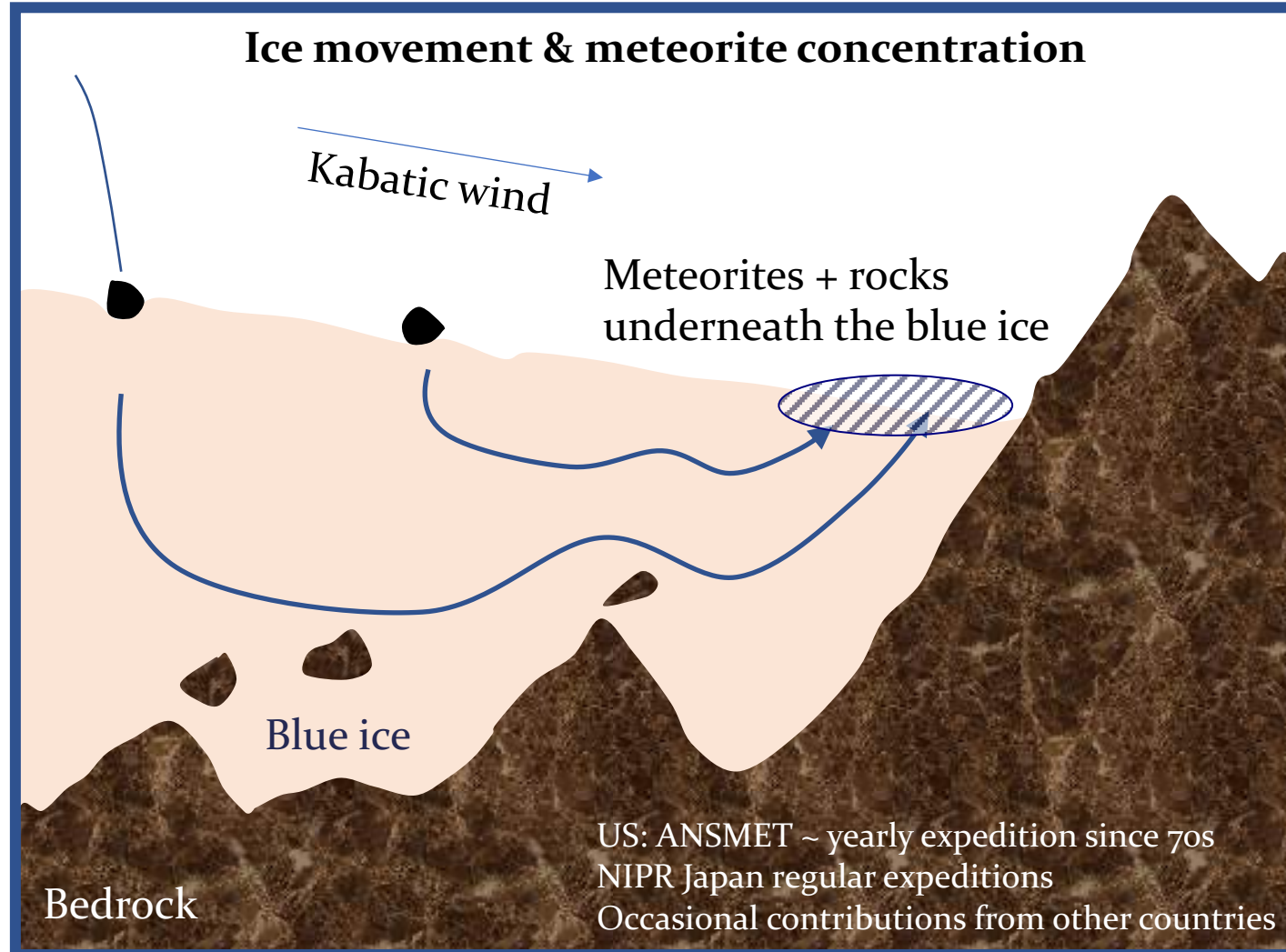
Magnetic observatory at PEA since 2018 (RMI)

Meteorite recovery areas in Antarctica



Why is Antarctica so important for finding meteorites?

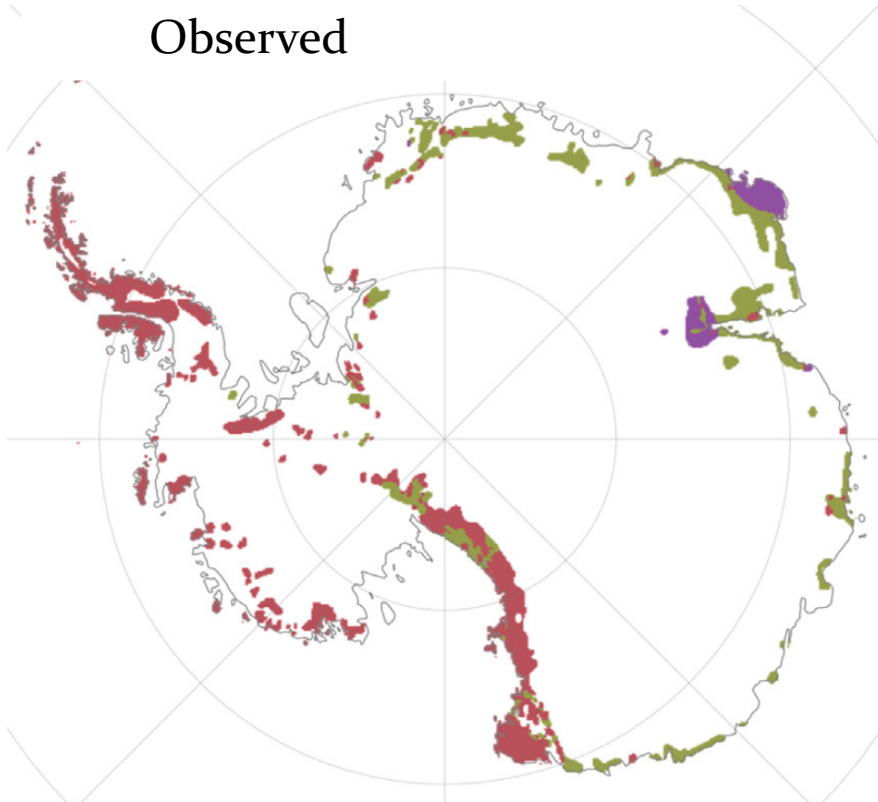
- Meteorites **easily found** (black spots on white ice)
- **Limited terrestrial alteration**
- Area **protected** from commercial abuse by the Antarctic Treaty
- **Concentration of meteorites** due to glacier movements



70145 valid meteorite names,
47154 approved from Antarctica (67%)
Meteoritical Bulletin Database, 2022

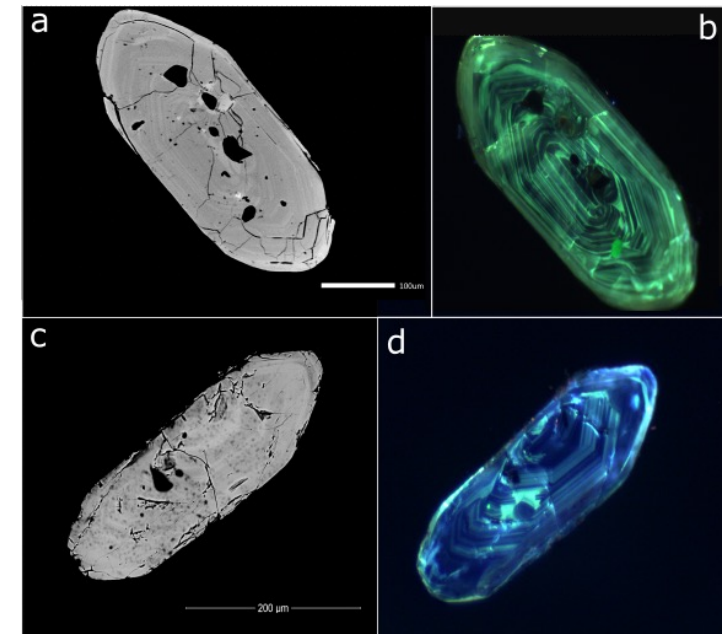
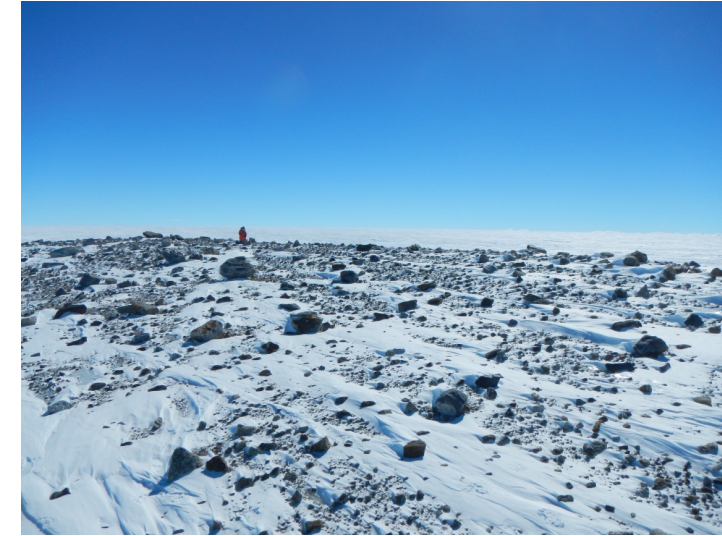
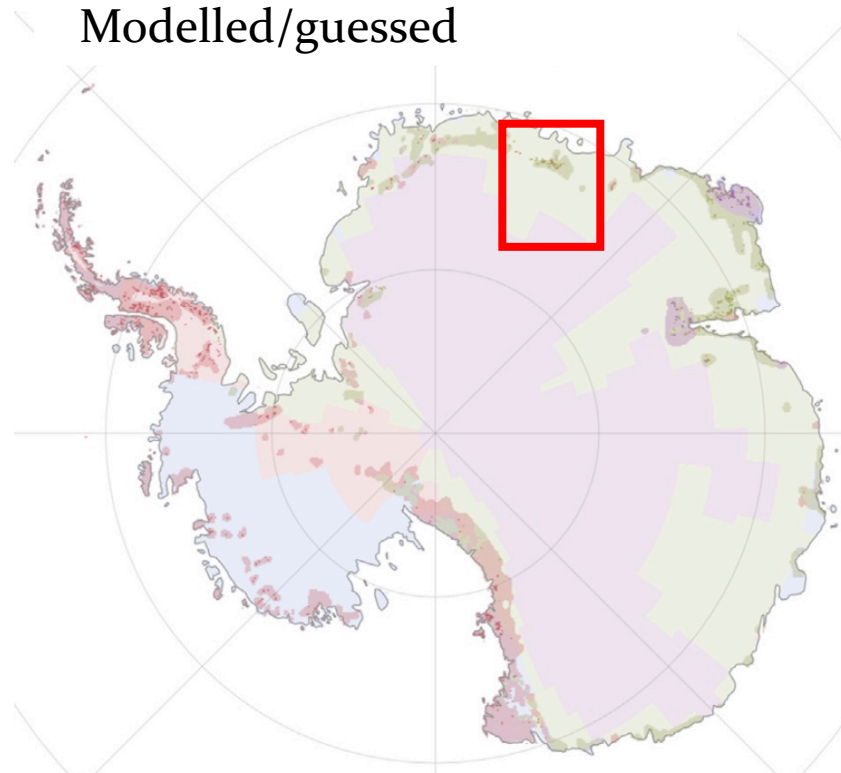
Unravelling the rock underneath the ice

Observed



Stal et al. (2020)

Modelled/guessed



“very old”

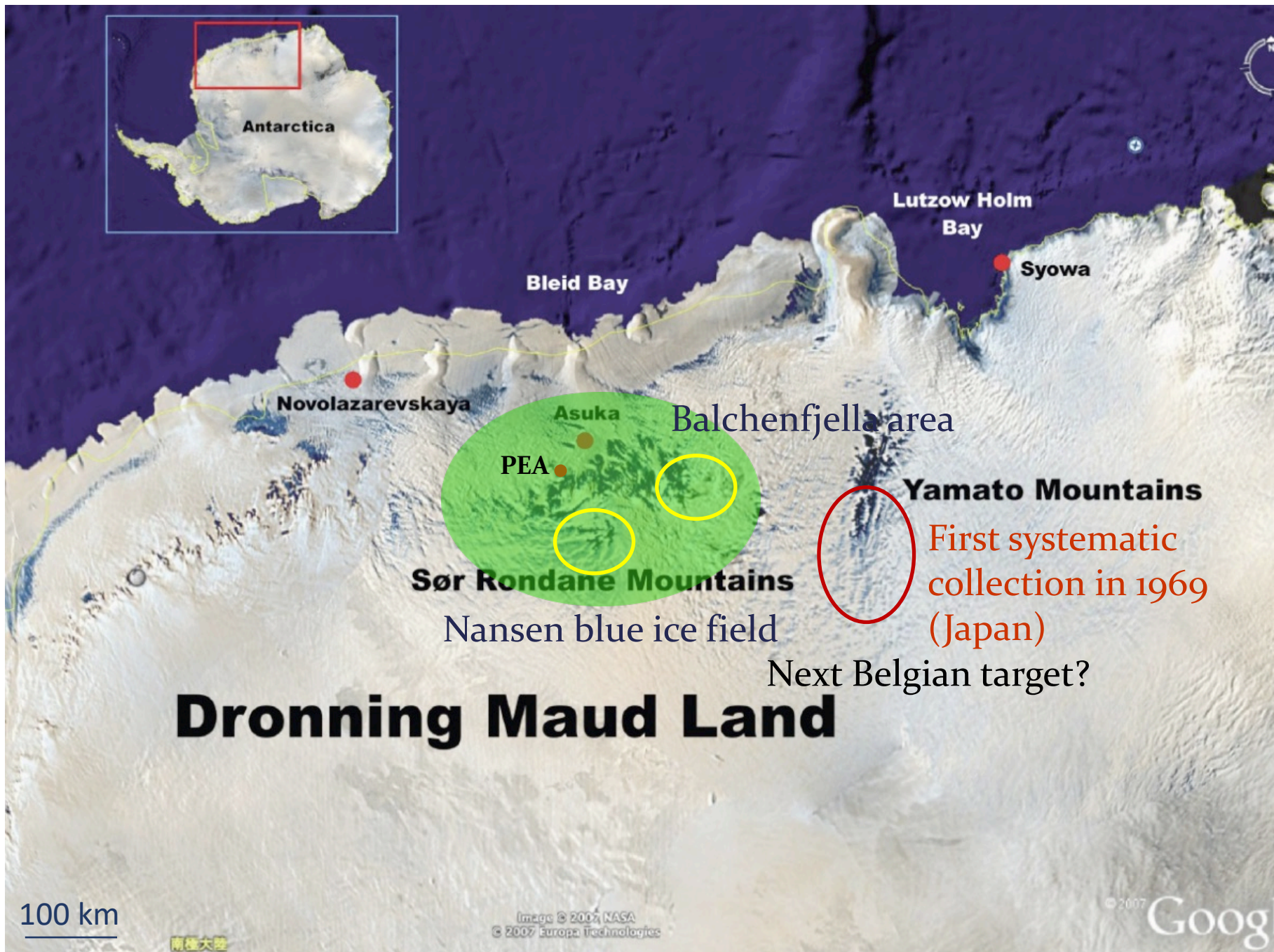


“very young”

- Archean
- Proterozoic
- Phanerozoic
- Oceanic

Presence of very ancient rock (older than 2.7 billion years) under the ice South of PEA?

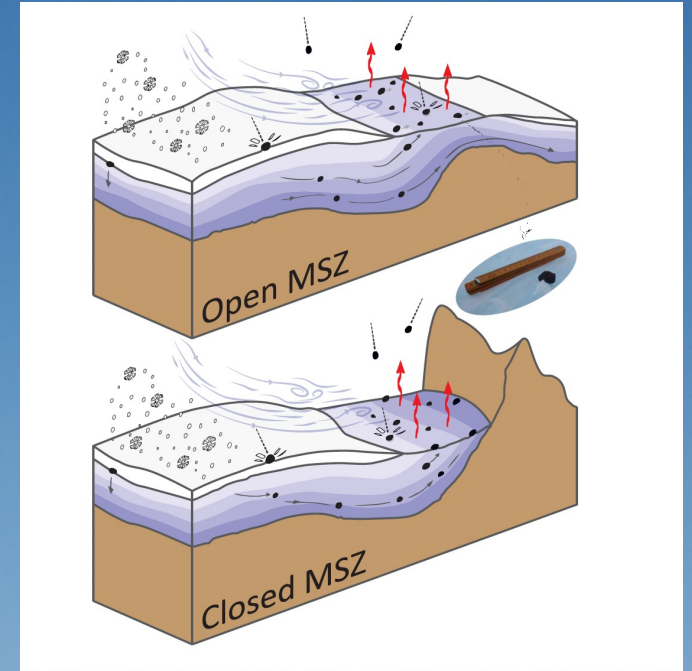
> **Rely on moraines and zircon ages**



First find: 1912
(Australia) in
Adelie Land

Meteorite fragments on blue ice

Focus on bare ice fields by means of skidoo or on foot.

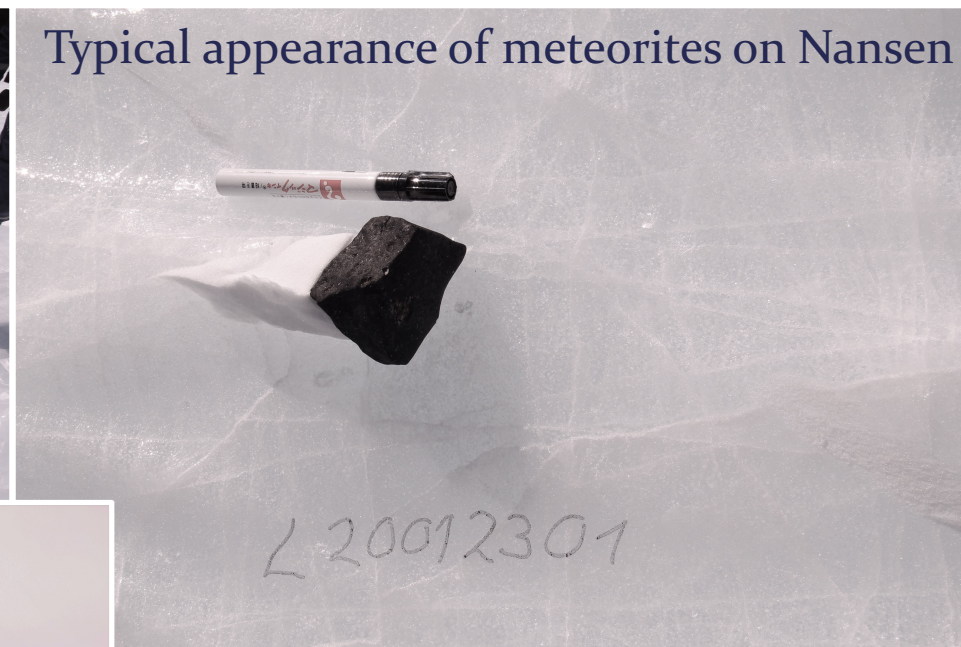


Tollenaar et al. 2022 *Sci. Adv.*





Typical appearance of meteorites on Nansen



2012-13 field season: 18 kg chondrite, 5th largest Antarctic meteorite

Close up



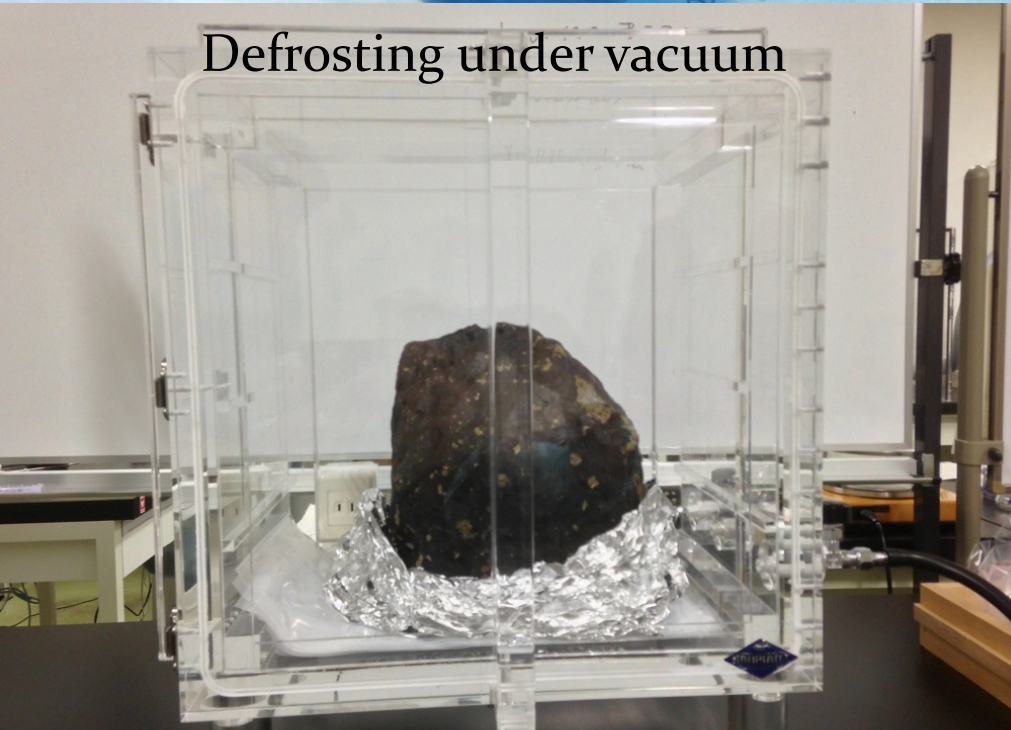
On the scale



Freezer at NIPR ~ -15°C



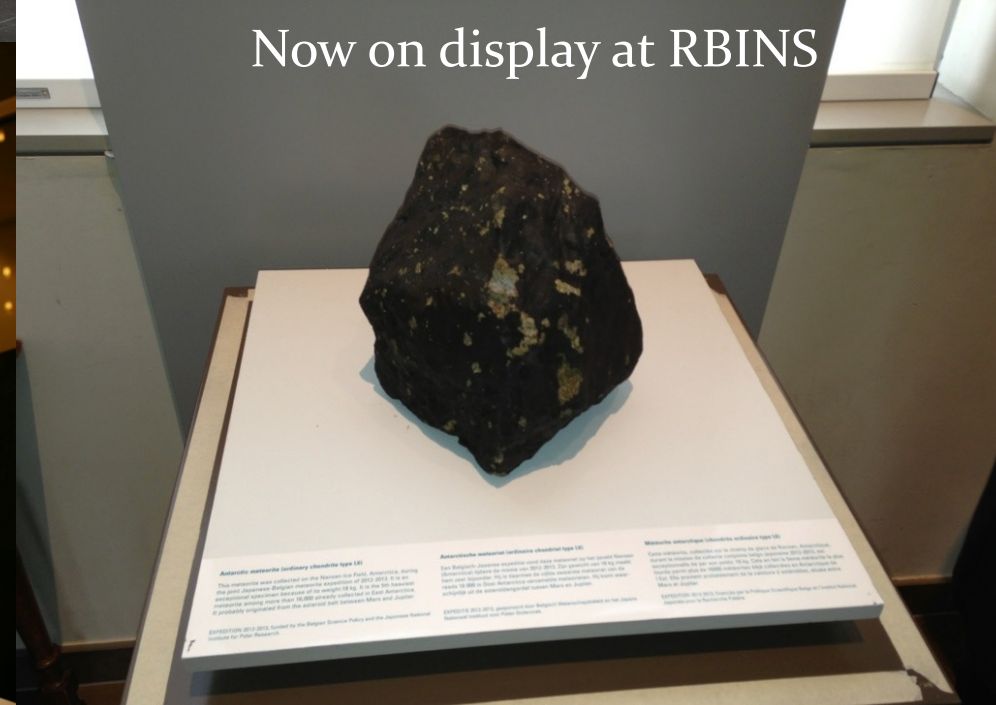
Defrosting under vacuum



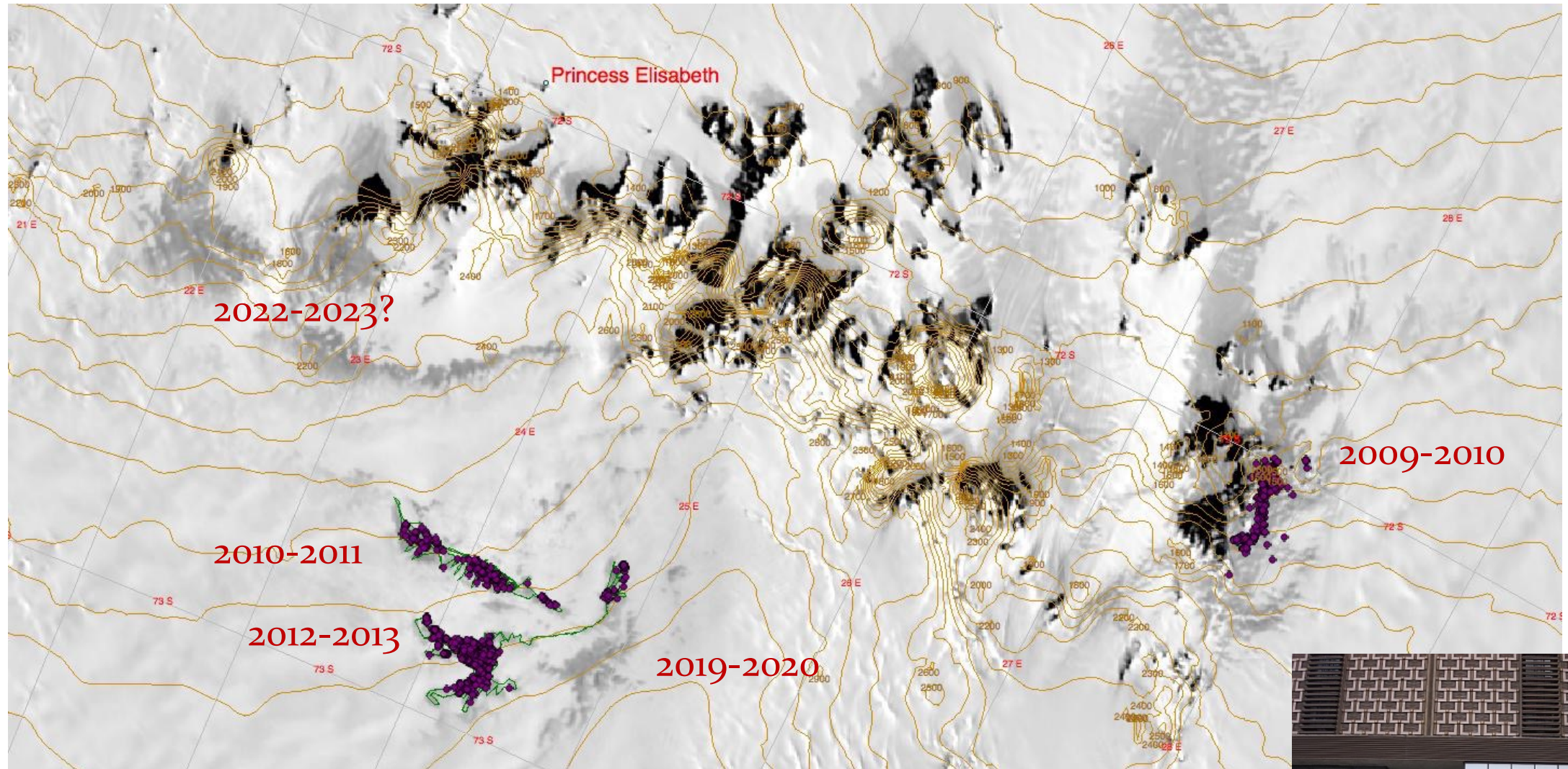
At Embassy in Tokyo



Now on display at RBINS



Japanese-Belgian meteorite collaboration



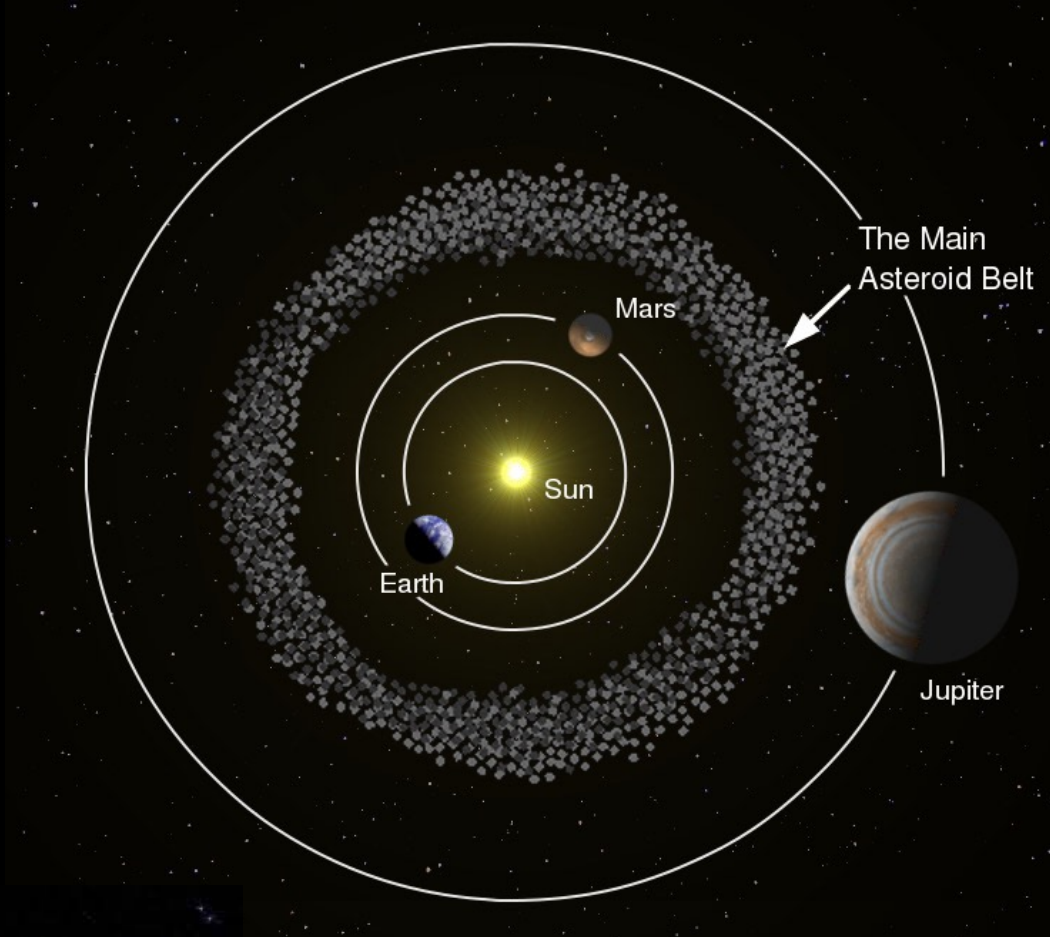
- Meteorites shared in half between Japan and Belgium for curation
- Partnership between RBINS, VUB and ULB for curation in Belgium & for distribution worldwide for scientific research

Asuka meteorites

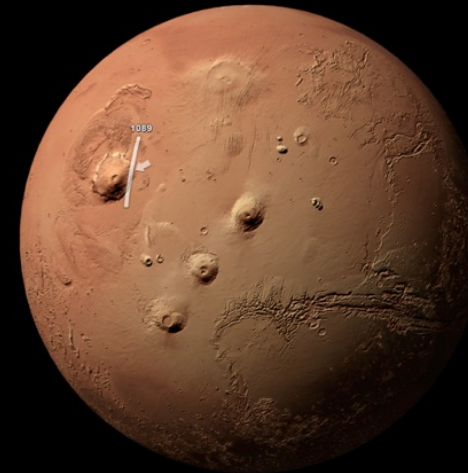
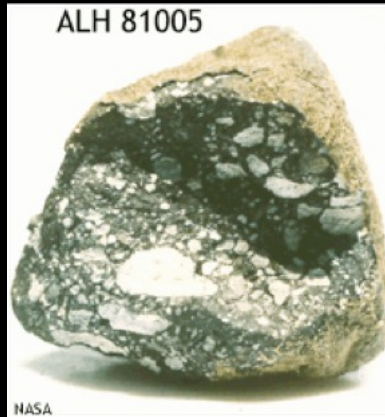
>3350 specimens found around the Sør Rondane Mountains

Field season (Name)	Mission	Number of meteorites	Bare ice field
1986-1987 (Asuka-86)	JARE-27	3	Mt. Balchen
1987-1988 (Asuka-87)	JARE-29	~100 ~200 352 total	Mt. Balchen Nansen Icefield
1988-1989 (Asuka-88)	JARE-29	1597	Nansen Icefield
1990-1991 (Asuka-90)	JARE-31	48	Mt. Balchen
2009-10 (Asuka-09)	JARE 51/BELARE-SAMBA	635	Mt. Balchen
2010-11 (Asuka-10)	BELARE-SAMBA	218	Nansen Icefield (area A, NW)
2012-13 (Asuka-12)	JARE 53/BELARE-SAMBA	424	Nansen Icefield (area B, SW+NE)
2018-2019 (Asuka-18)	TAE-3	3	Nansen Ice Field (area A, NW)
2019-2020 (Asuka-20)	BELARE-BELAM/TAE-4	66	Nansen Ice Field (area C, SE)

Fragments from asteroids, the Moon and Mars



Moon



Mars

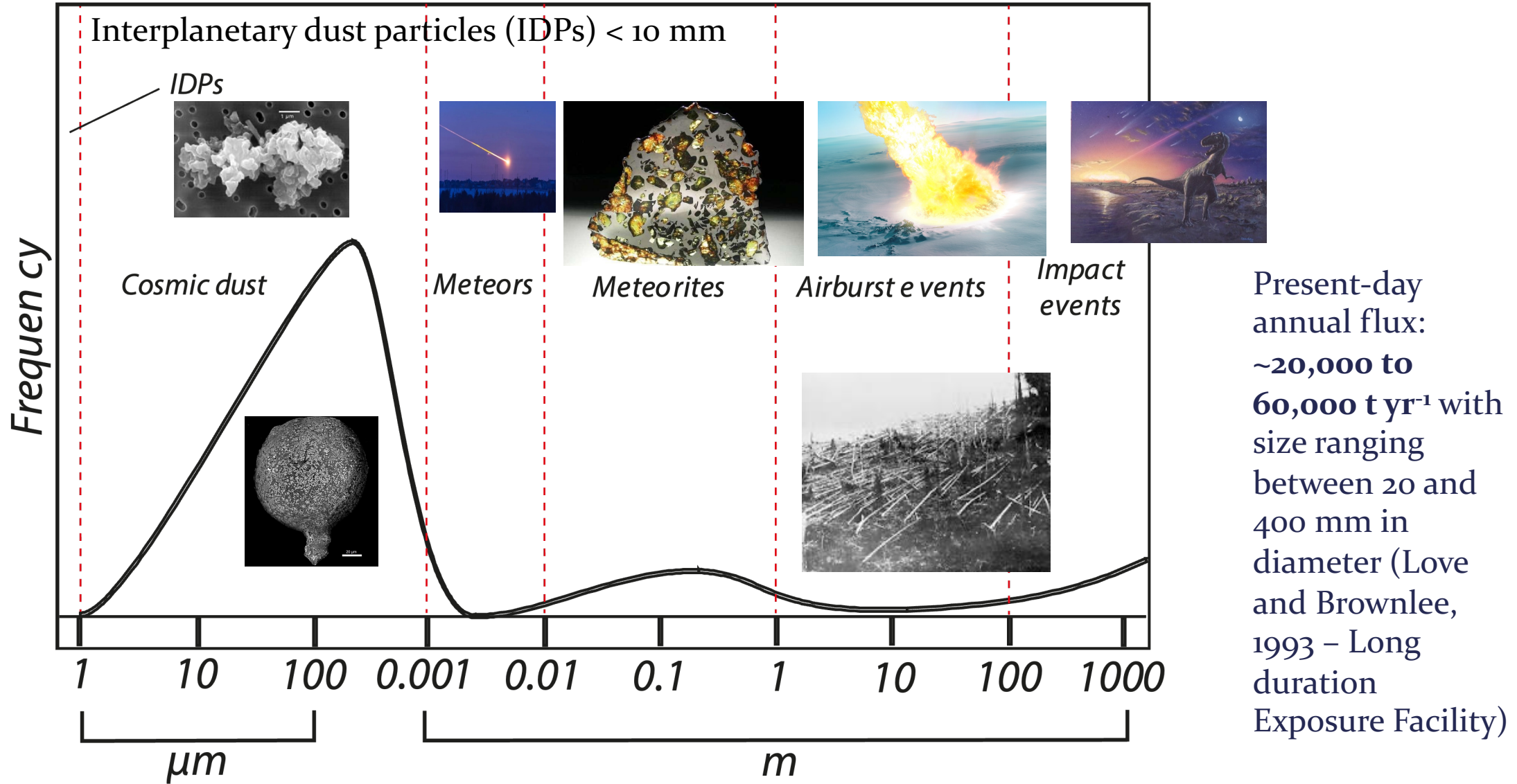


Representative sampling of the (inner) Solar System

Hayabusa2 to asteroid Ryugu

But also... micrometeorites

- Largest fraction of flux of extraterrestrial material to Earth (1000x normal meteorite flux)

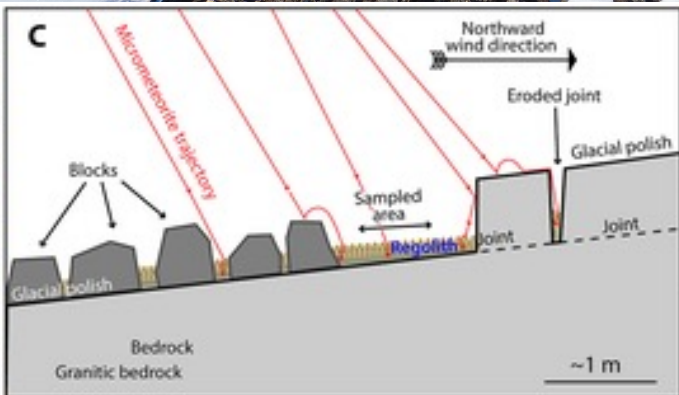


Approximate volumetric contribution of extraterrestrial material (M. Genge - Imperial College London)

Long accumulation & excellent preservation in the SRM

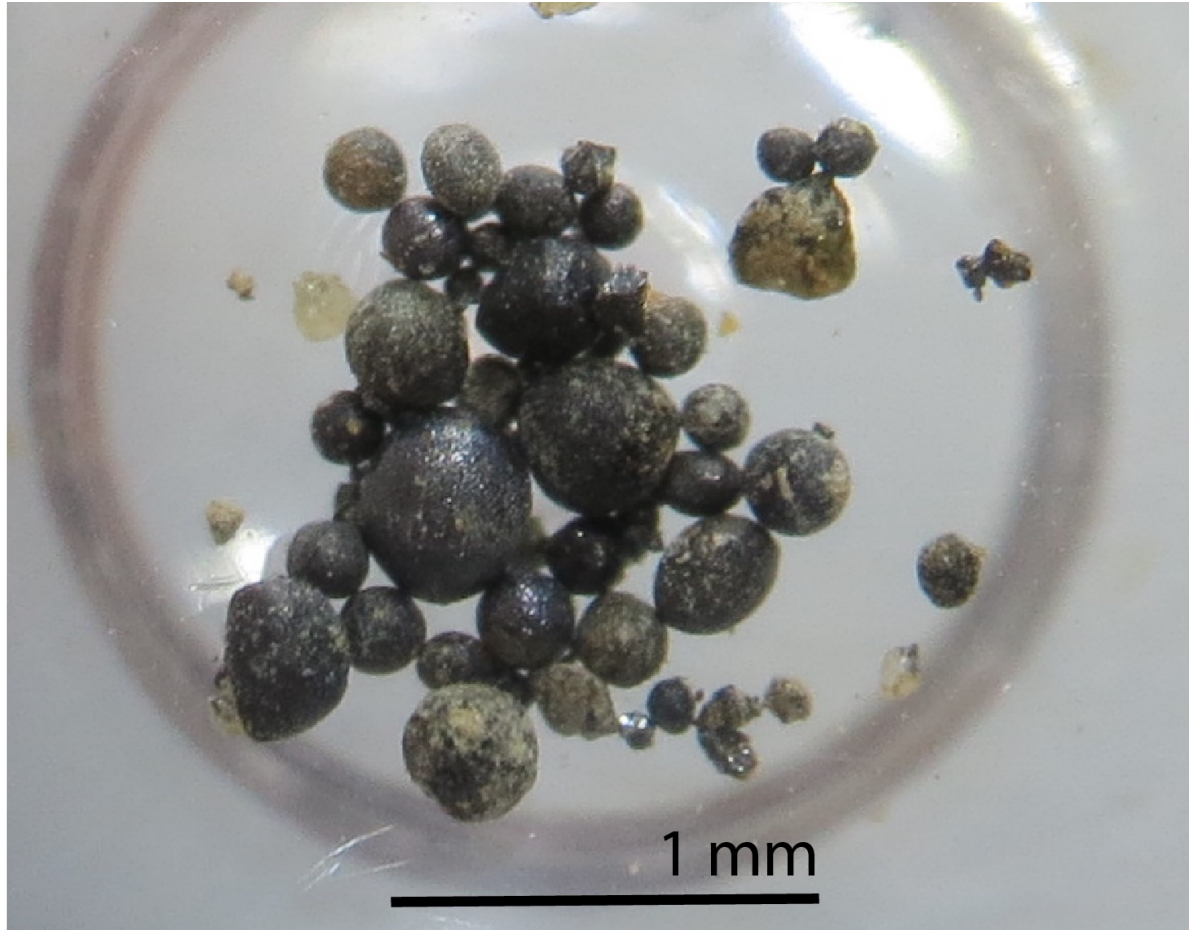
Glacially eroded surfaces with old cosmic-ray exposure ages (based on ^{10}Be up to 2-3 Myr and more)

Walnumfjellet, Sør Rondane Mts.



Suttle et al. (2020)

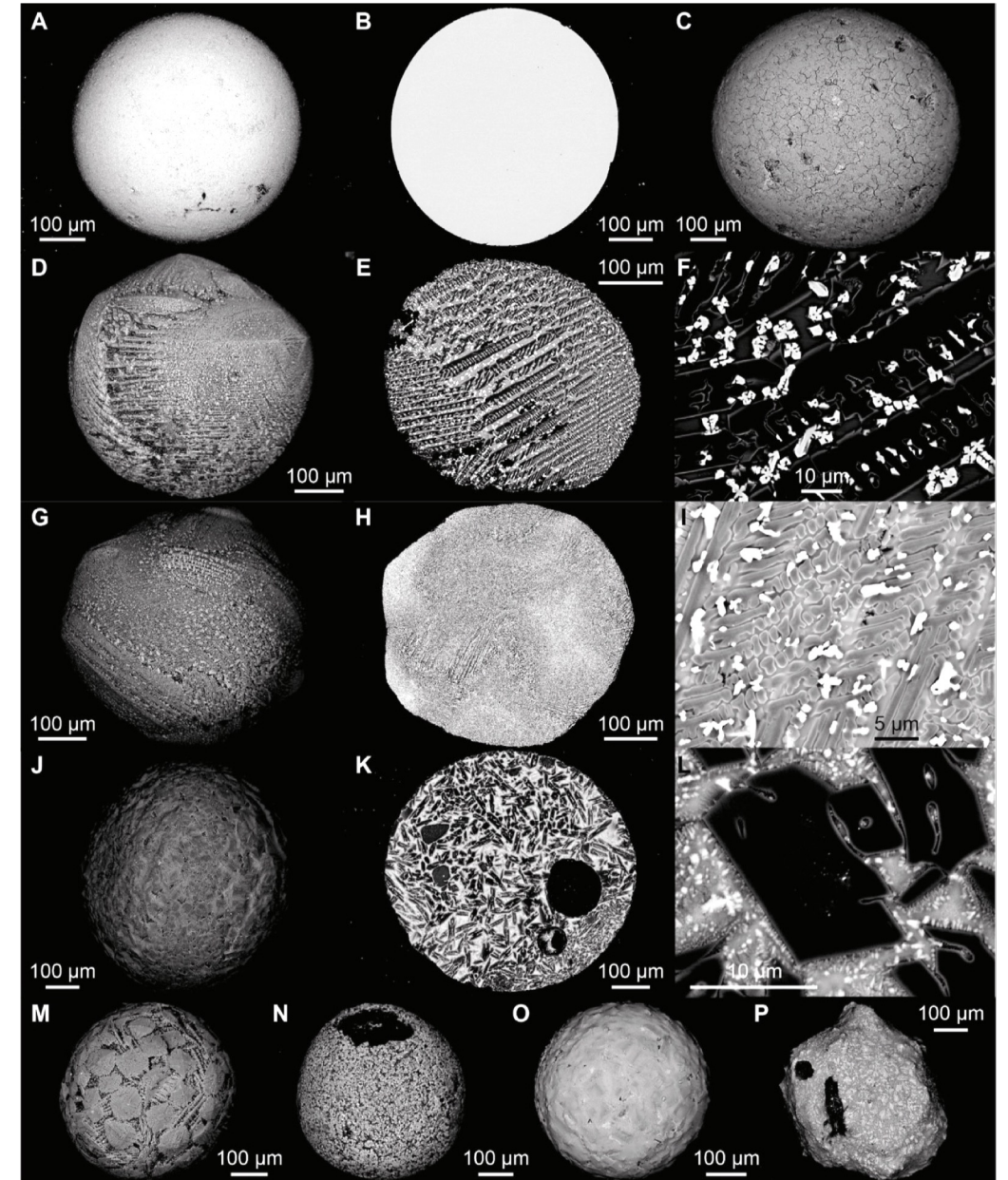
Abundant and large micrometeorites



~5 min of picking at the Antarctic research station
Collection of 10,000s micrometeorites

Overview of cosmic spherules from Widerøefjellet:
All major types present!

Goderis et al. (2020)



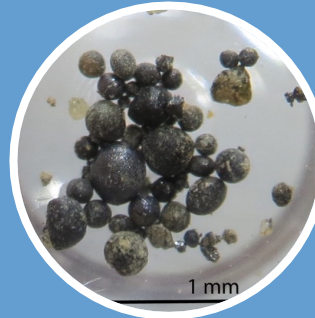
Scientific outcome



5 successful expeditions dedicated to the recovery of meteorites, micro-meteorites and impact crater products in vicinity of Princess Elisabeth station



1346 Antarctic meteorites from the Sør Rondane Mountains (2% all meteorites) in excellent state of preservation



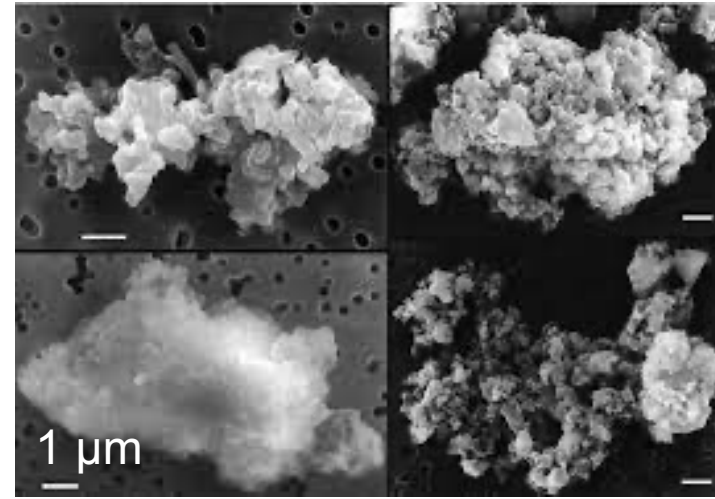
>50,000 Antarctic micrometeorites in VUB collection



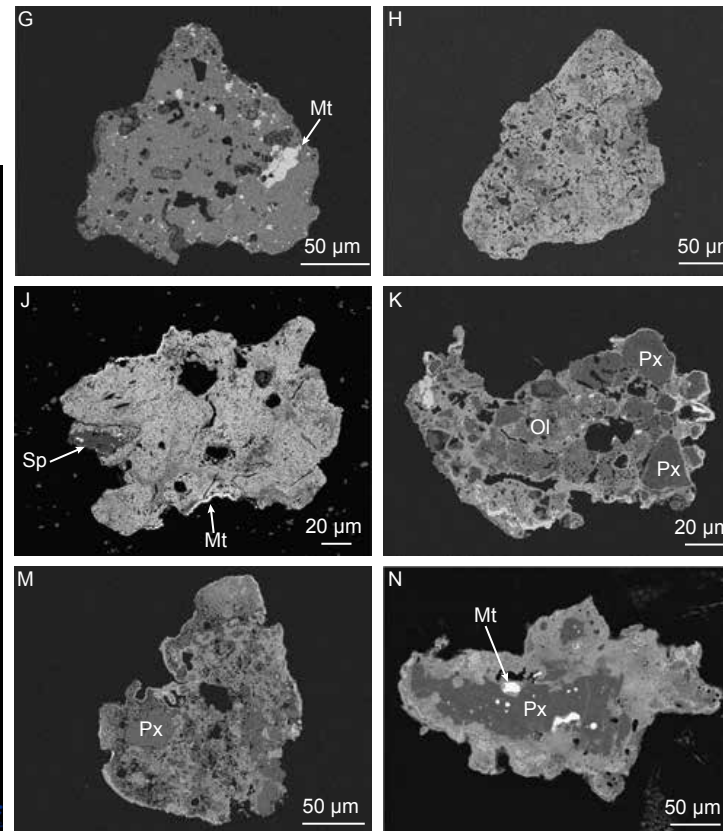
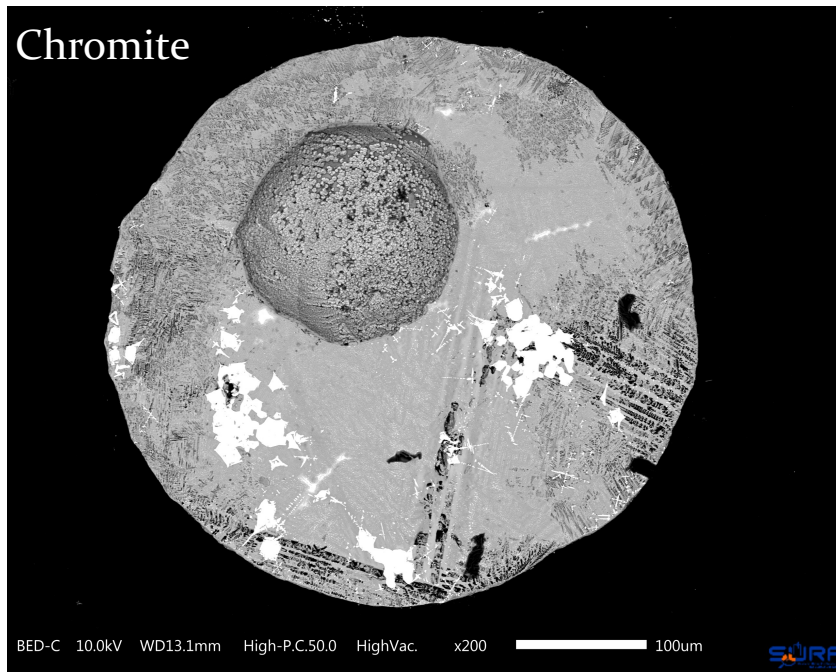
Valuable addition to Belgian patrimony, available to scientific community after proposal submission

As for the future...

- Belgica or Yamato Mountains?
- Even smaller sizes?
- More unmelted and scoriaceous?
- Individual (relict) mineral phases?
- Fossil micrometeorites throughout the geological record?
- ...?



Images of four interplanetary dust particles (IDPs) collected in the stratosphere (Dai and Bradley, 2001; Hanner and Bradley, 2001; Jessberger et al., 2001)



Partially unmelted micrometeorites from the Sør Rondane Mountains (Van Maldeghem et al., forthcoming)

Thank you!
Questions? Steven.Goderis@vub.be



ANALYTICAL, ENVIRONMENTAL
& GEO-CHEMISTRY
RESEARCH GROUP



NiPR
National Institute of Polar Research



Imperial College
London

University of
Kent



The Field
Museum

ETH zürich

And many others



