

Université de Liège
Faculté des Sciences
Département de Géologie
Laboratoire de Minéralogie



Géologie du Massif de Stavelot

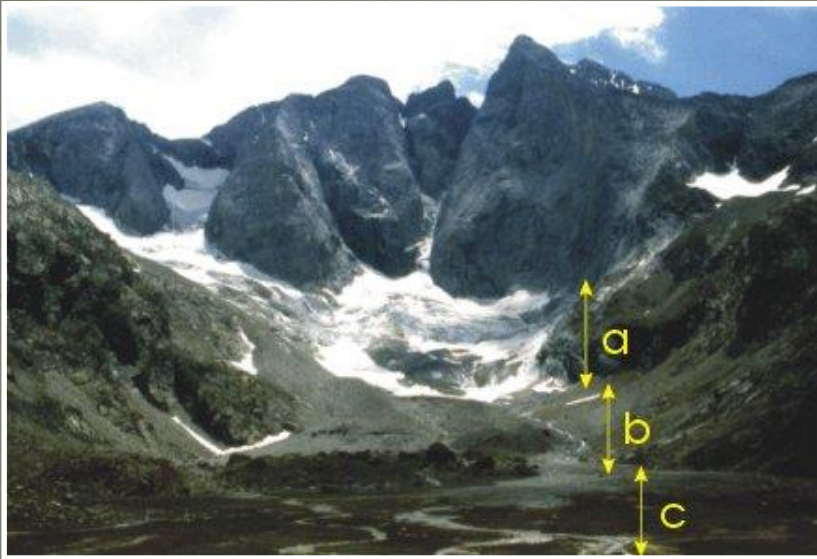
Prof. Frédéric Hatert

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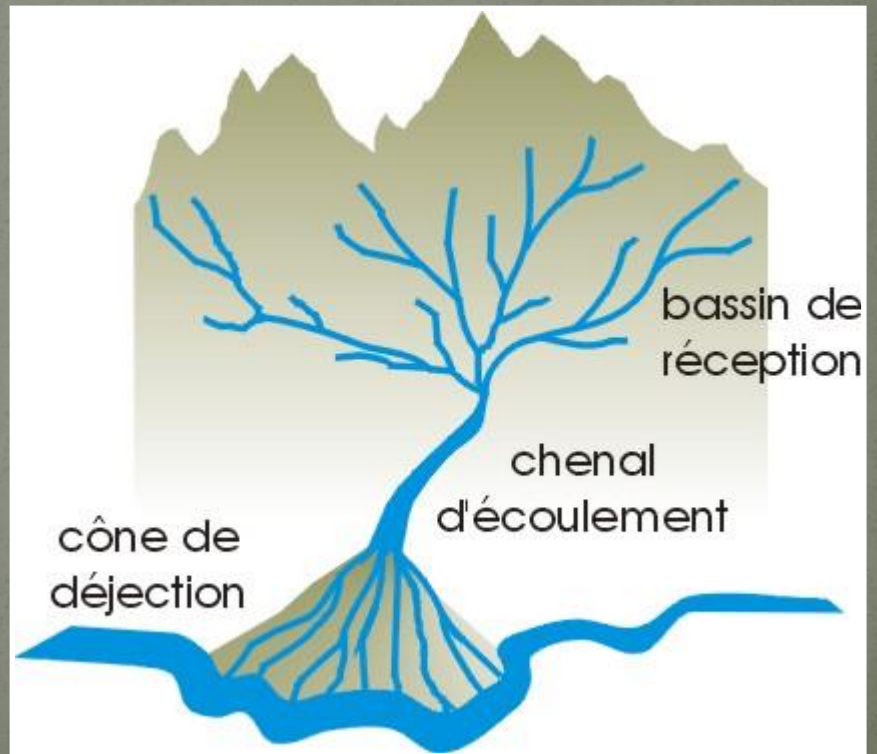


- Notions générales de Géologie
- Le Massif de Stavelot
- Les minéraux du Massif de Stavelot
- Le coticule
- De l'or en Ardenne

Les roches sédimentaires

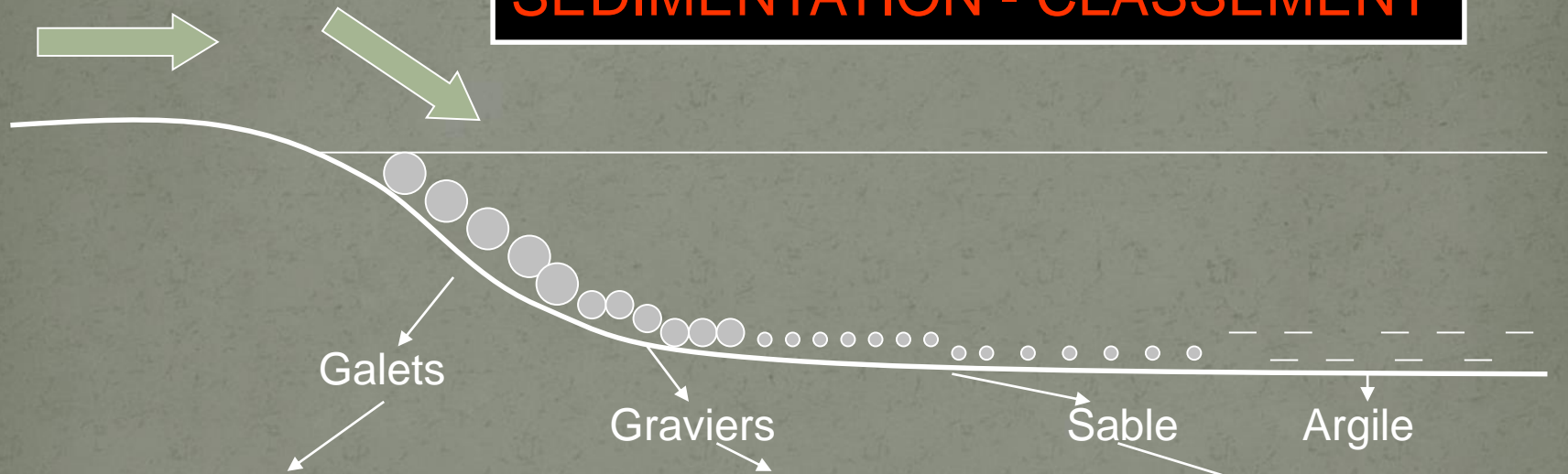


EROSION - TRANSPORT



Les roches sédimentaires

SEDIMENTATION - CLASSEMENT



Les roches sédimentaires

DIAGENESE

Galets



Sable



Conglomérat

Graviers

Grès

Argiles

Arkose

Argilite



Les roches métamorphiques



METAMORPHISME

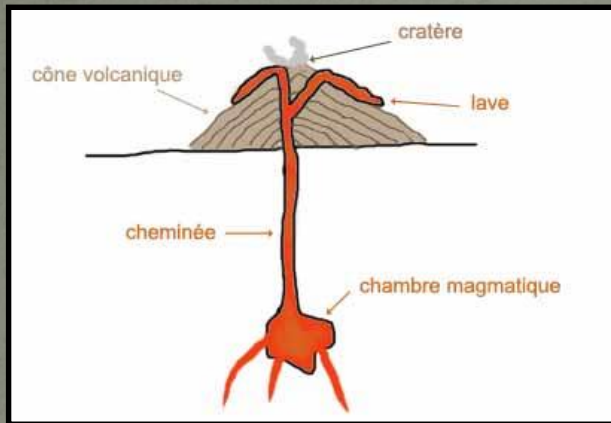
OROGENESE – HP HT



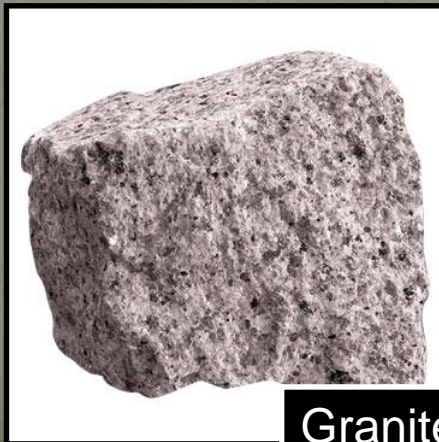
Micaschiste à grenats

Les roches magmatiques

INTRUSIVES



EXTRUSIVES

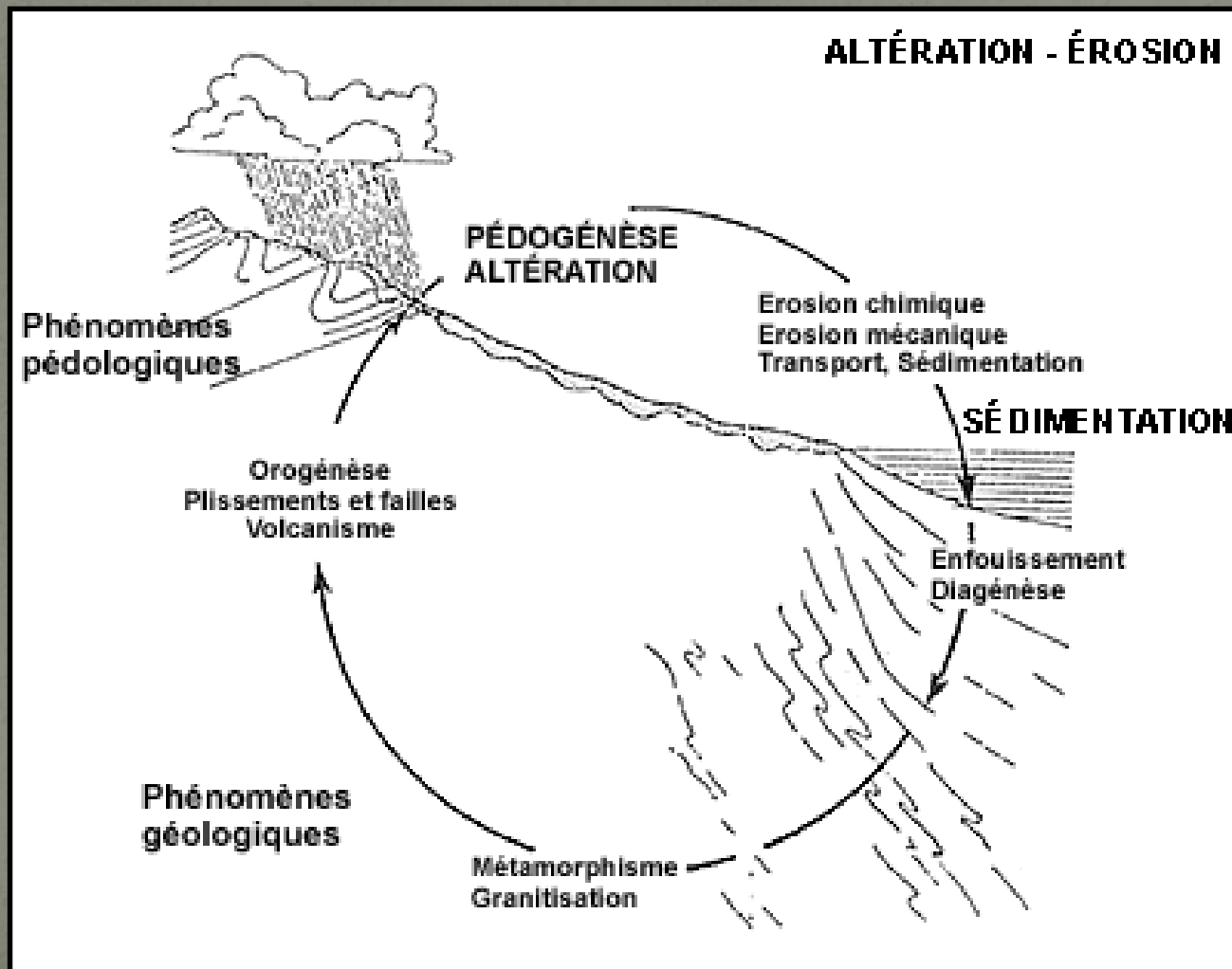


Granite



Basalte

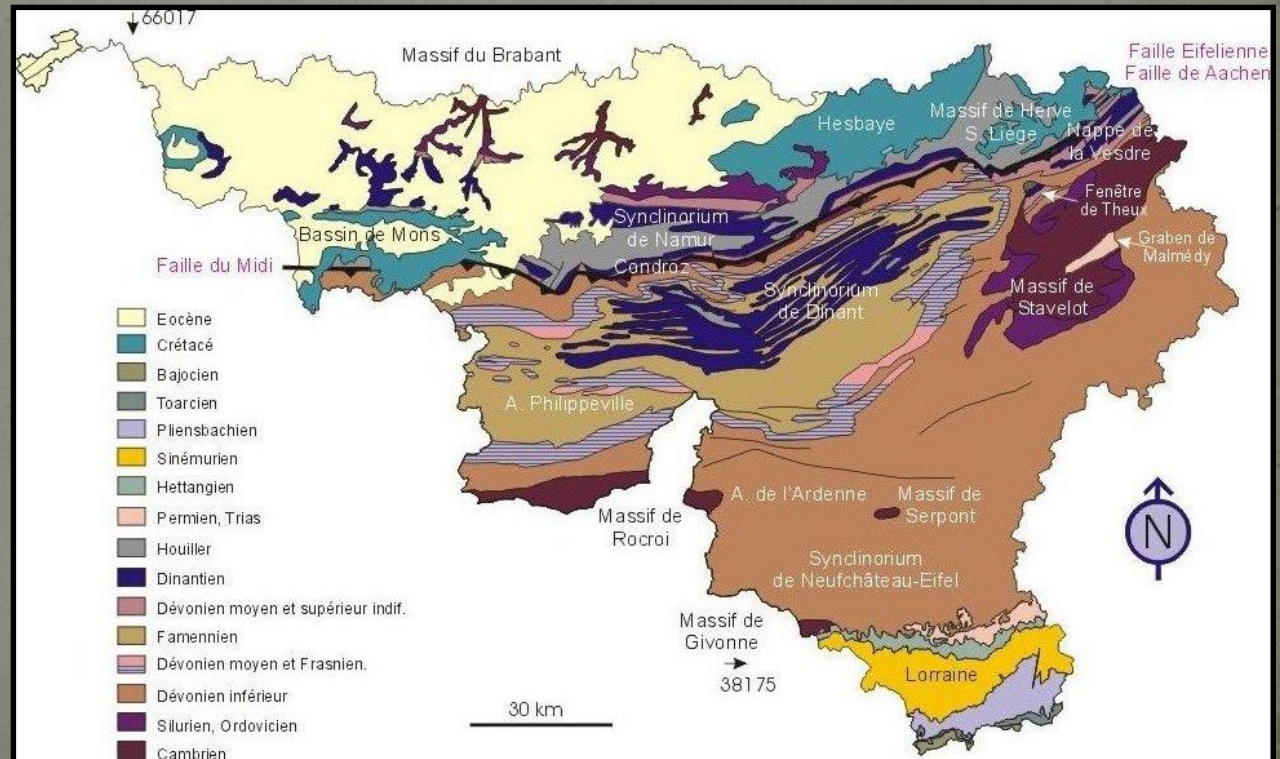
Le cycle géologique



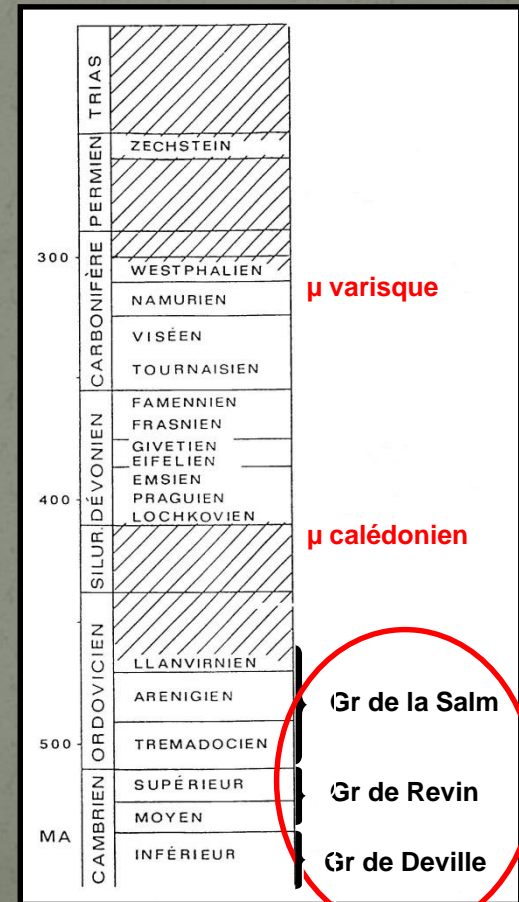
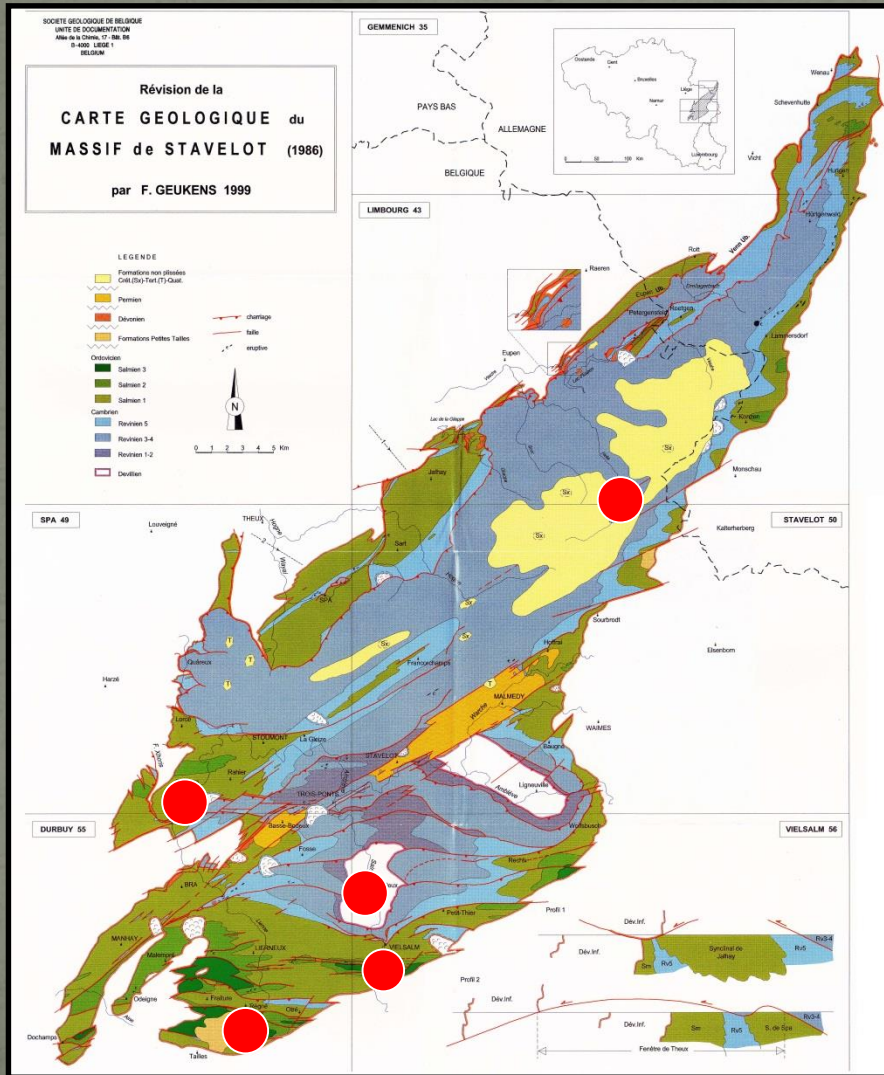
Géologie de la Belgique

| Éon | Ère | Période | Époque | Ma | |
|---------------|---------------|-------------|---------------|--------------|-----|
| PHANÉROZOÏQUE | CÉNOZOÏQUE | QUATERNAIRE | HOLOCÈNE | 0,01 | |
| | | | PLÉISTOCÈNE | 1,8 | |
| | | NÉOGÈNE | PLIOCÈNE | 5 | |
| | | | MIOCÈNE | 23 | |
| | | PALÉOGÈNE | OLIGOCÈNE | 34 | |
| | | | ÉOCÈNE | 56 | |
| | MÉSOZOÏQUE | PALÉOGÈNE | PALÉOGÈNE | 66 | |
| | | | CRÉTACÉ | 146 | |
| | | | JURASSIQUE | 200 | |
| | | | TRIASSIQUE | 251 | |
| | | | PERMIEN | PERMIEN | 299 |
| | | | | CARBO-NIFÈRE | 318 |
| | | | PENNSYLVANIEN | 359 | |
| | | | MISSISSIPIEN | 416 | |
| PALÉOZOÏQUE | PERMIEN | DÉVONIEN | 444 | | |
| | | SILURIEN | 488 | | |
| | | ORDOVICIEN | 542 | | |
| | | CAMBRIEN | 2500 | | |
| PRÉCAMBRIEN | PROTÉROZOÏQUE | ARCHÉEN | 3800 | | |
| | | HADÉEN | 4600 | | |

Massifs cambro-ordoviciens: Stavelot, Rocroi, Serpont, Givonne



Le Massif de Stavelot



Métamorphisme calédonien

Métamorphisme calédonien

--~ 430 Ma
-200-350°C

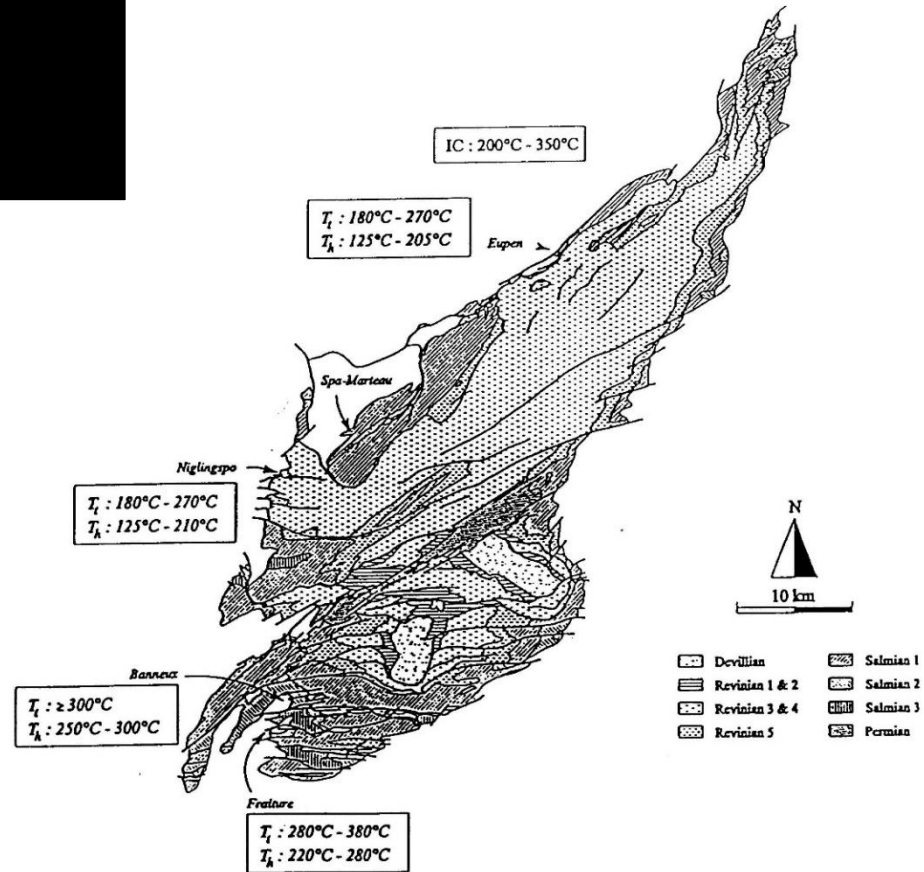
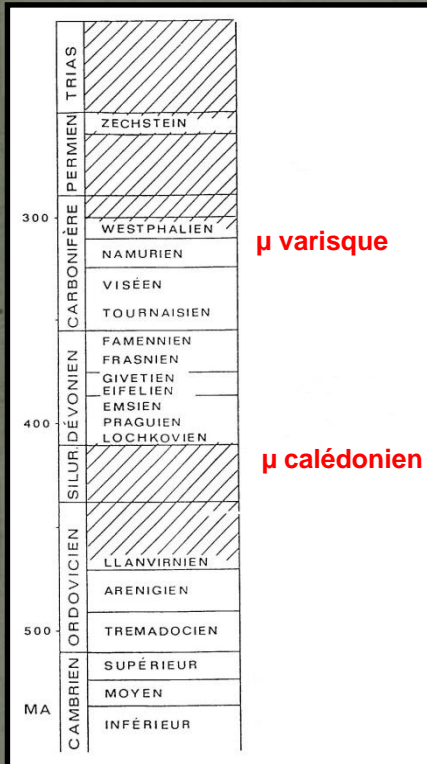
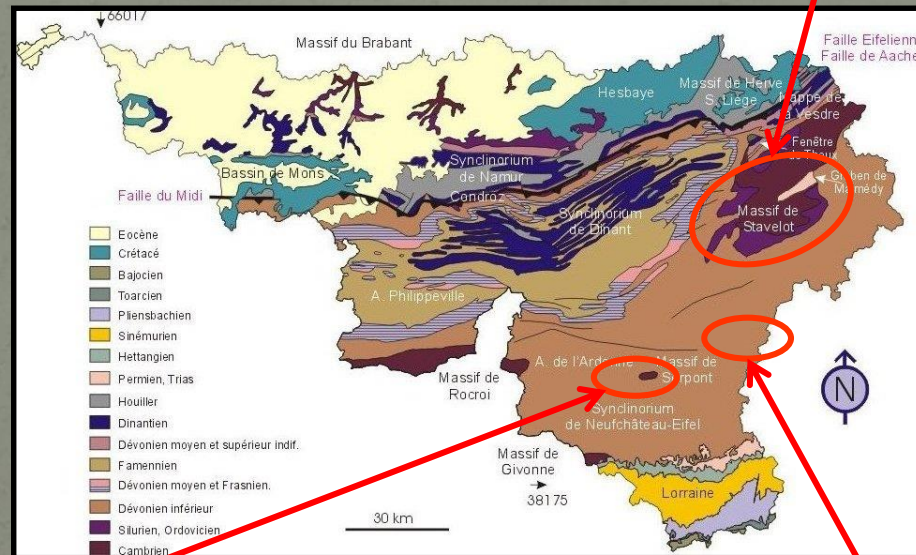


Fig. 3. Thermal conditions during the Caledonian orogeny in the Stavelot-Venn Massif. I.C. : illite crystallinity, T_h : total homogenisation temperatures of fluid inclusions, T_t : trapping temperatures of fluid inclusions.

Métamorphisme varisque



Massif de Stavelot
 420°C/2-3 kbar (Vallée de la Salm)
 380°C/2 kbar (Vallée de la Lienne)



Zone de Libramont
 500°C/3-4 kbar

Zone de Bastogne
 400°C/2 kbar

Vielsalm-Salmchâteau



Bulletin de la Société Royale des Sciences de Liège, Vol. 86, articles, 2017, p. 1 - 48

Données nouvelles sur quelques espèces minérales de Vielsalm et de Salmchâteau

(Province de Luxembourg, Belgique)

Manuscrit reçu le 21 janvier 2017 et accepté le 27 mars 2017

Michel BLONDIEAU¹, Stéphane PUCCIO², Philippe COMPERE³, Frédéric HATERT⁴



Sm2c

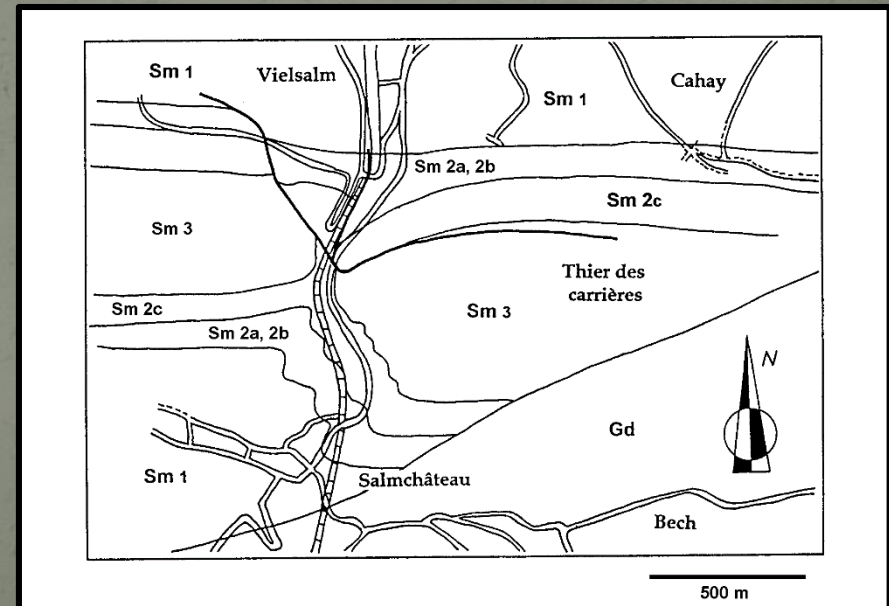
Membre de « Colanhan »
Phyllades gris-vert-violet
Veines de sulfures de cuivre

Sm2b

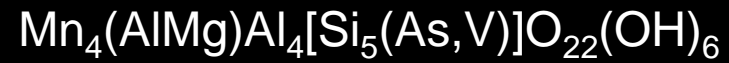
Membre de « Les Plattes »
Phyllades rouges à coticule

Sm2a

Membre de « Meuville »
Phyllades rouges à oxydes de Mn



L'ardennite



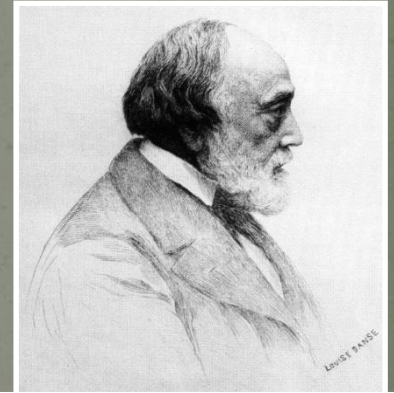
Dewalquite (Pisani, 1872)



Ardennite (von Lasaulx, 1872)



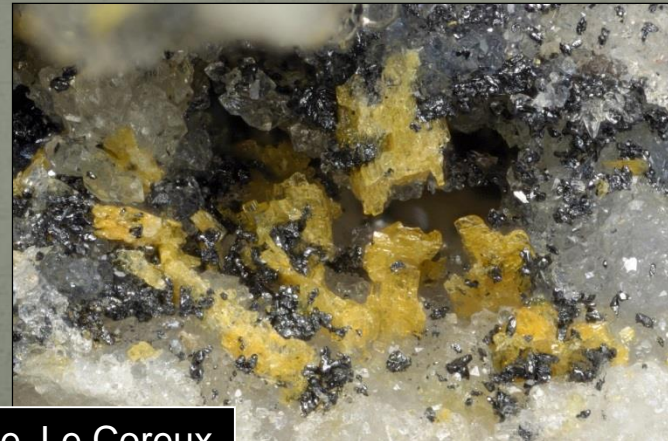
Ardennite, Salmchâteau



Gustave Dewalque
(1828-1905)



Ardennite, Salmchâteau



Ardennite, Le Coreux

Nouveau minéral !

Davreuxite-Stavelotite



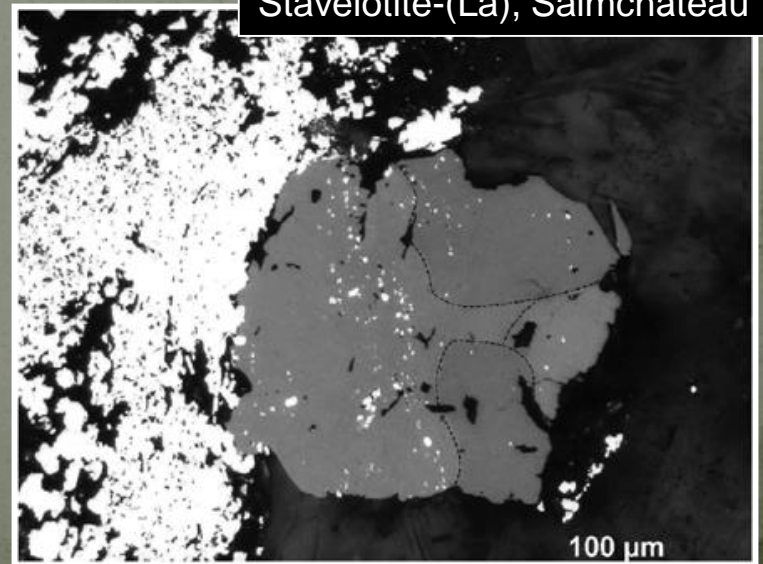
Davreuxite, Salmchâteau

Davreuxite
 $\text{MnAl}_6\text{Si}_4\text{O}_{17}(\text{OH})_2$

Charles-Joseph Davreux
(1800-1863)
Chimiste et naturaliste,
Liège

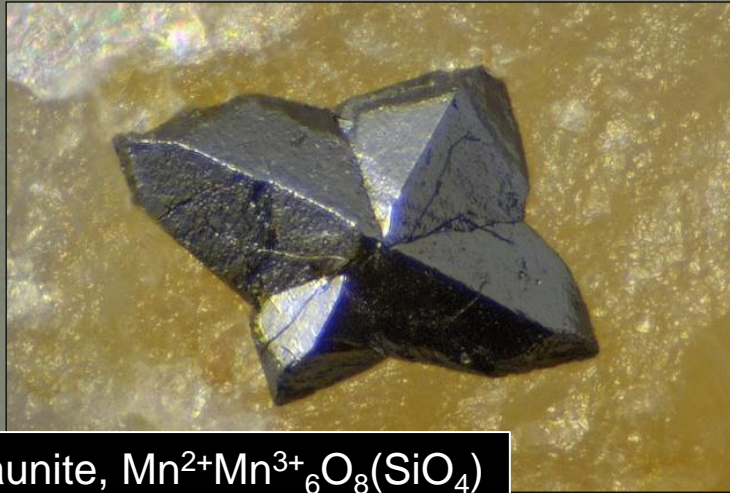
!!! Nouvelle espèce 😊 !!!

Stavelotite-(La)
 $\text{La}_3(\text{Mn}^{2+})_3\text{Cu}^{2+}(\text{Mn}^{3+}, \text{Fe}^{3+}, \text{Mn}^{4+})_{26}(\text{Si}_2\text{O}_7)_6\text{O}_{30}$



Stavelotite-(La), Salmchâteau

Les oxydes de manganèse



Braunitz, $\text{Mn}^{2+}\text{Mn}^{3+}_6\text{O}_8(\text{SiO}_4)$
Le Coreux



Pyrolusite, MnO_2
Le Coreux



Lithiophorite, $(\text{Al}, \text{Li})(\text{Mn}^{4+}, \text{Mn}^{3+})\text{O}_2(\text{OH})_2$
Vielsalm



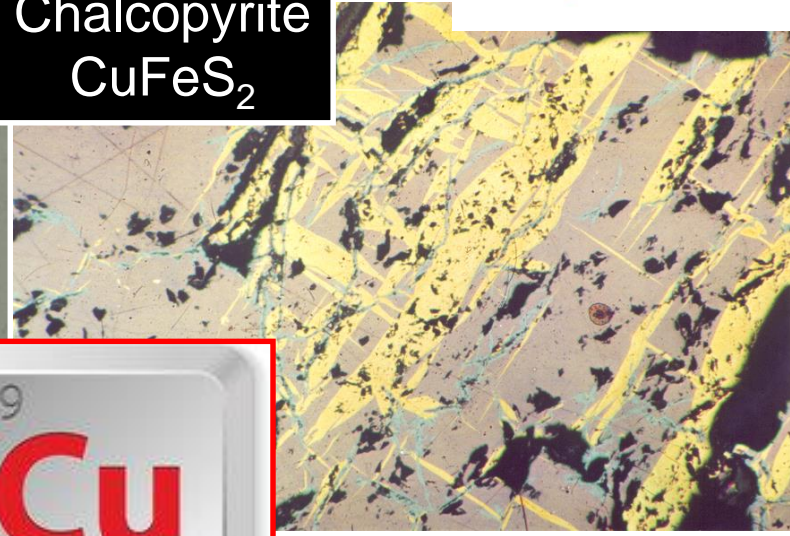
Hollandite-strontiomélanite, $(\text{Ba}, \text{Sr})(\text{Mn}^{4+}_6\text{Mn}^{3+}_2)\text{O}_{16}$
Le Coreux

Les sulfures de cuivre

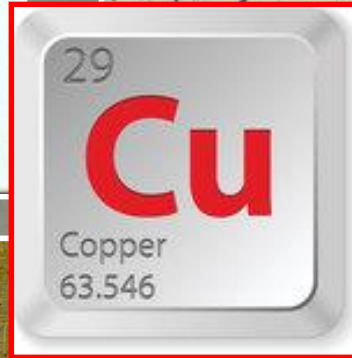
Bornite
 Cu_5FeS_4



Chalcopyrite
 CuFeS_2



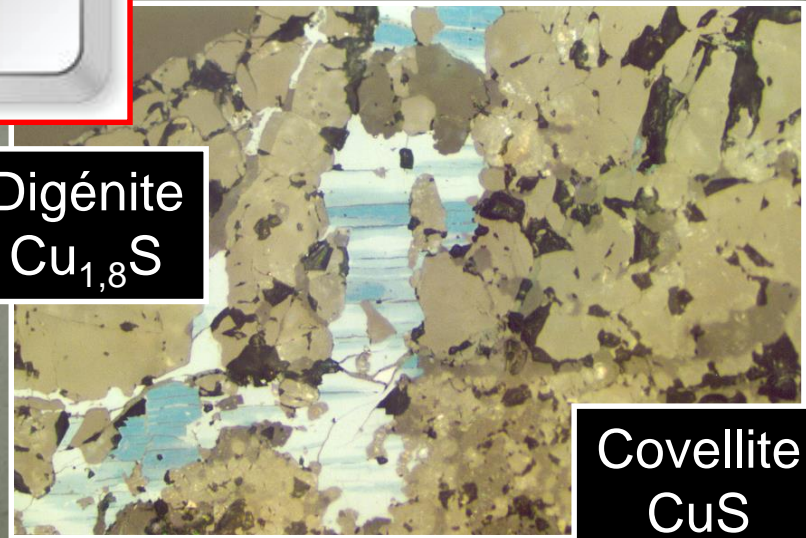
Chalcocite
 Cu_2S



Idaïte
 Cu_3FeS_4



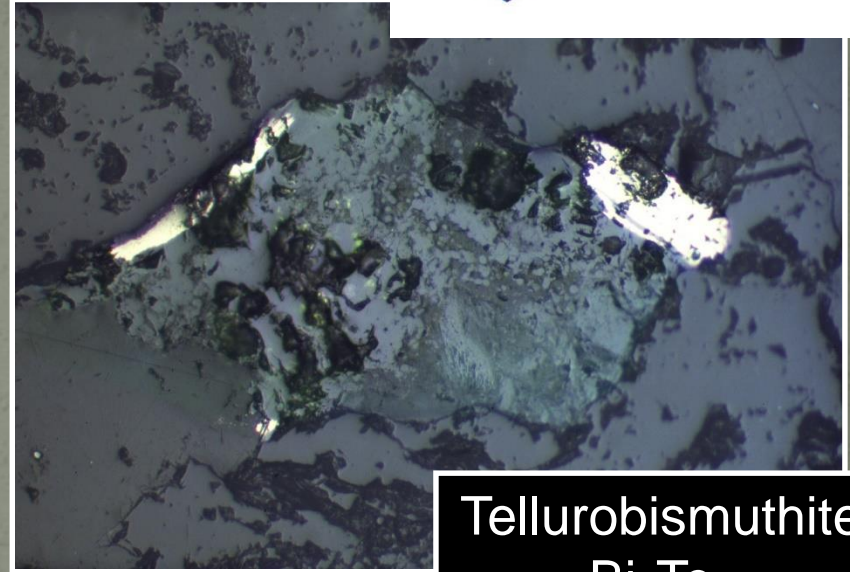
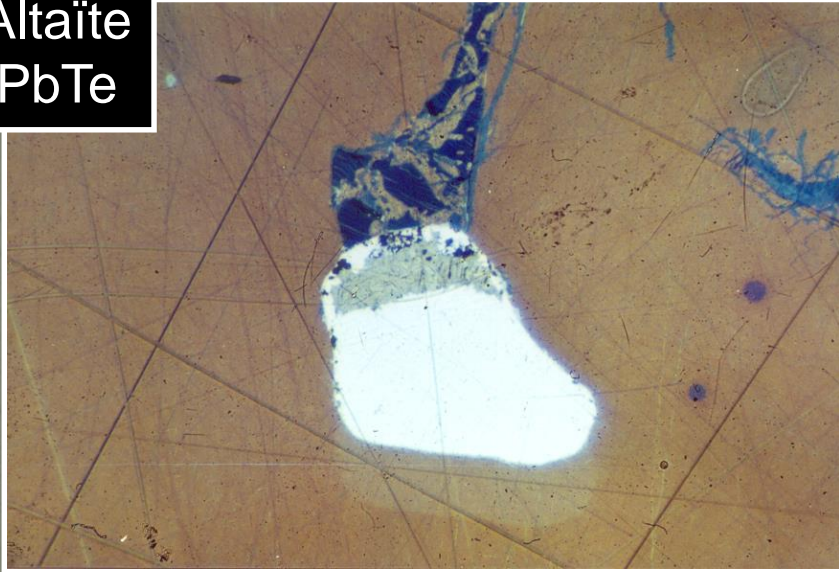
Digénite
 $\text{Cu}_{1,8}\text{S}$



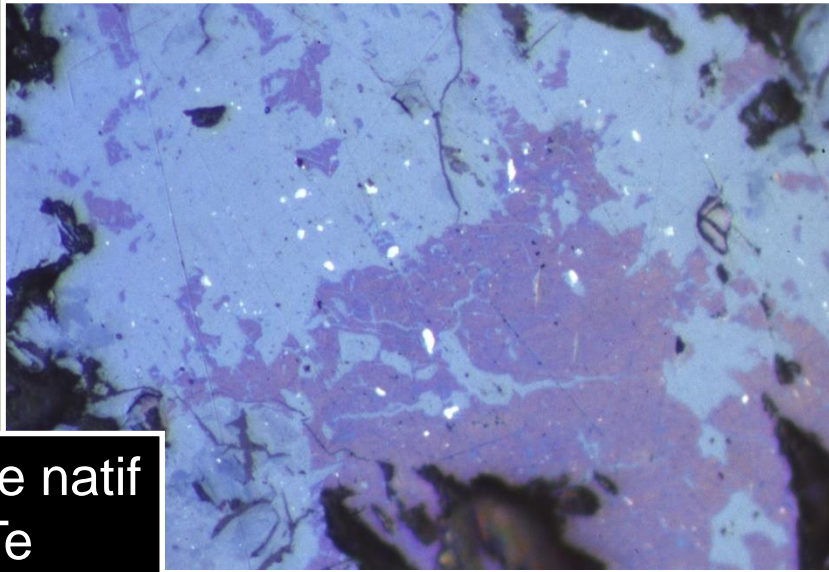
Covellite
 CuS

Les tellurures

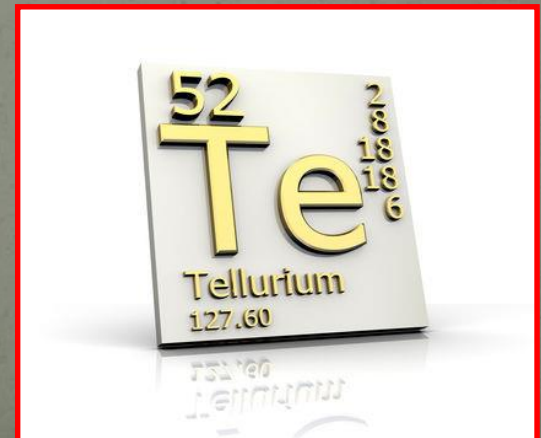
Altaïte
 PbTe



Tellurobismuthite
 Bi_2Te_3



Tellure natif
 Te



Arséniates et vanadates

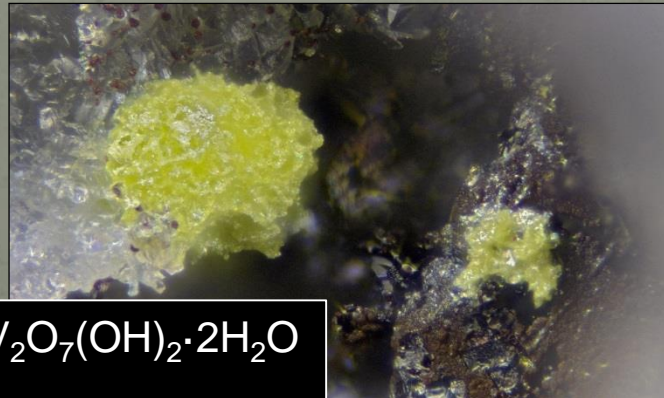


Arsénogoyazite,
 $\text{SrAl}_3(\text{AsO}_4)(\text{AsO}_3\text{OH})(\text{OH})_6$
Le Coreux



Scorodite, $\text{Fe}^{3+}(\text{AsO}_4) \cdot 2\text{H}_2\text{O}$
Vielsalm

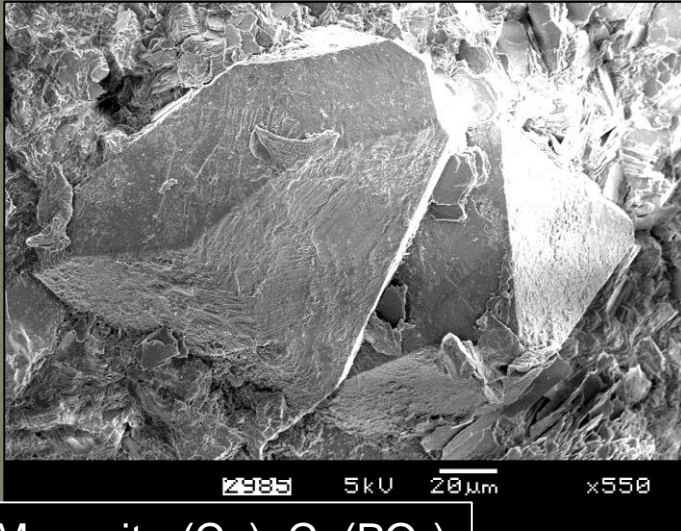
**Nouveaux
pour la
Belgique !**



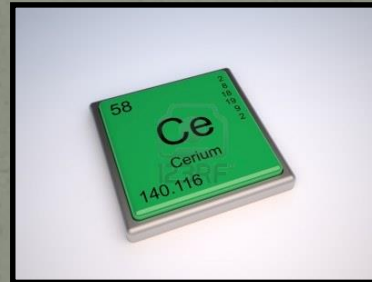
Volborthite, $\text{Cu}_3\text{V}_2\text{O}_7(\text{OH})_2 \cdot 2\text{H}_2\text{O}$
Vielsalm



Les minéraux de terres rares



Monazite-(Ce), $\text{Ce}(\text{PO}_4)$
Salmchâteau



Xénotime-(Y), YPO_4
Salmchâteau



Xénotime-(Y), YPO_4
Vielsalm

Les minéraux uranifères

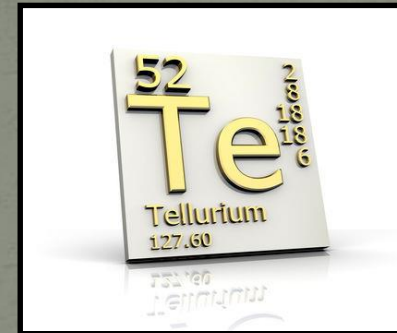
Métatorbernite
 $\text{Cu}^{2+}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$

!!! Minéral radioactif ☹️ !!!



Métatorbernite, Cahay

La montanite



Montanite, $\text{Bi}^{3+}_2\text{Te}^{6+}\text{O}_6 \cdot 2\text{H}_2\text{O}$
Vielsalm

| Vielsalm | Montanite [†] | | Montanite ^{**} | |
|--------------|------------------------|--------------------------------------|-------------------------|--------------------------------------|
| | Russie | | Montana (USA) | |
| <i>d</i> (Å) | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ (%) | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ (%) |
| 7,510 | - | - | - | - |
| 6,532 | - | - | - | - |
| 5,847 | - | - | - | - |
| 5,066 | - | - | - | - |
| 4,164 | - | - | - | - |
| 3,320 (TF) | 3,54 3,223 | 100 50 | 3,49 | 100 |
| 3,049 (TF) | 2,950 | 30 | 3,187 | 40 |
| 2,533 (F) | 2,600 | 90 | 2,576 | 75 |
| 2,050 (F) | 2,041 | 25 | 2,027 | 40 |
| 1,906 (F) | 1,892 | 80 | 1,896 | 100 |
| 1,772 (F) | 1,708 | 55 | 1,709 | 30 |
| 1,656 (F) | 1,635 | 15 | 1,629 | 20 |
| 1,523 (F) | 1,504 | 30 | 1,503 | 50 |
| 1,445 | - | - | 1,434 | 20 |
| 1,387 | 1,358 | 10 | 1,357 | 15 |
| 1,292 | - | - | 1,292 | 30 |
| 1,255 | 1,249 | 15 | 1,255 | 35 |
| 1,224 | - | - | 1,230 | 20 |
| 1,193 | - | - | 1,198 | 15 |
| 1,099 | - | - | 1,093 | 30 |



Nouveau pour la Belgique !

La malhmoodite



| Echantillon 1* | Echantillon2** | Malhmoodite*** | |
|----------------|----------------|----------------|--------------------------------------|
| Vielsalm | Vielsalm | Arkansas, USA | |
| <i>d</i> (Å) | <i>d</i> (Å) | <i>d</i> (Å) | <i>I</i> / <i>I</i> ₀ (%) |
| 9,282 | 9,596 | 9,58 | 75 |
| 7,137 | 7,015 | - | - |
| - | 5,902 | - | - |
| 4,447 | 4,412 | 4,563 | 65 |
| | | 4,384 | 80 |
| 4,114 | 4,098 | 4,090 | 60 |
| 3,602 | 3,587 | 3,974 | 40 |
| 3,176 | 3,185 | 3,266 | 20 |
| 2,867 | 2,820 | 3,160 | 100 |
| 2,660 | 2,661 | 2,661 | 20 |
| - | - | 2,640 | 70 |
| - | - | 2,574 | 15 |
| - | - | 2,046 | 15 |
| 2,191 | 2,192 | - | - |
| 2,014 | 2,008 | 1,999 | 20 |
| 1,886 | 1,886 | 1,990 | 25 |
| 1,781 | 1,788 | 1,783 | 20 |
| - | - | 1,738 | 15 |
| 1,703 | 1,702 | 1,706 | 20 |
| 1,667 | - | 1,663 | 10 |
| 1,541 | 1,546 | 1,580 | 15 |
| 1,488 | 1,453 | 1,523 | 20 |
| 1,332 | 1,331 | - | - |
| 1,278 | 1,272 | - | - |
| 1,236 | 1,237 | - | - |



Malhmoodite, $\text{FeZr}(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$
Vielsalm



Nouveau pour la Belgique !

Ottré-Bihain

!!! Nouveau minéral 😊 🍷

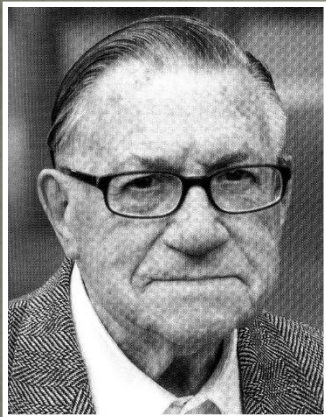
Ottrélite
 $\text{MnAl}_2\text{O}(\text{SiO}_4)(\text{OH})_2$



Ottrélite, Ottré



Chloritoïde, Vielsalm



René Van Tassel
(1916-2013)
Minéralogiste, Bruxelles

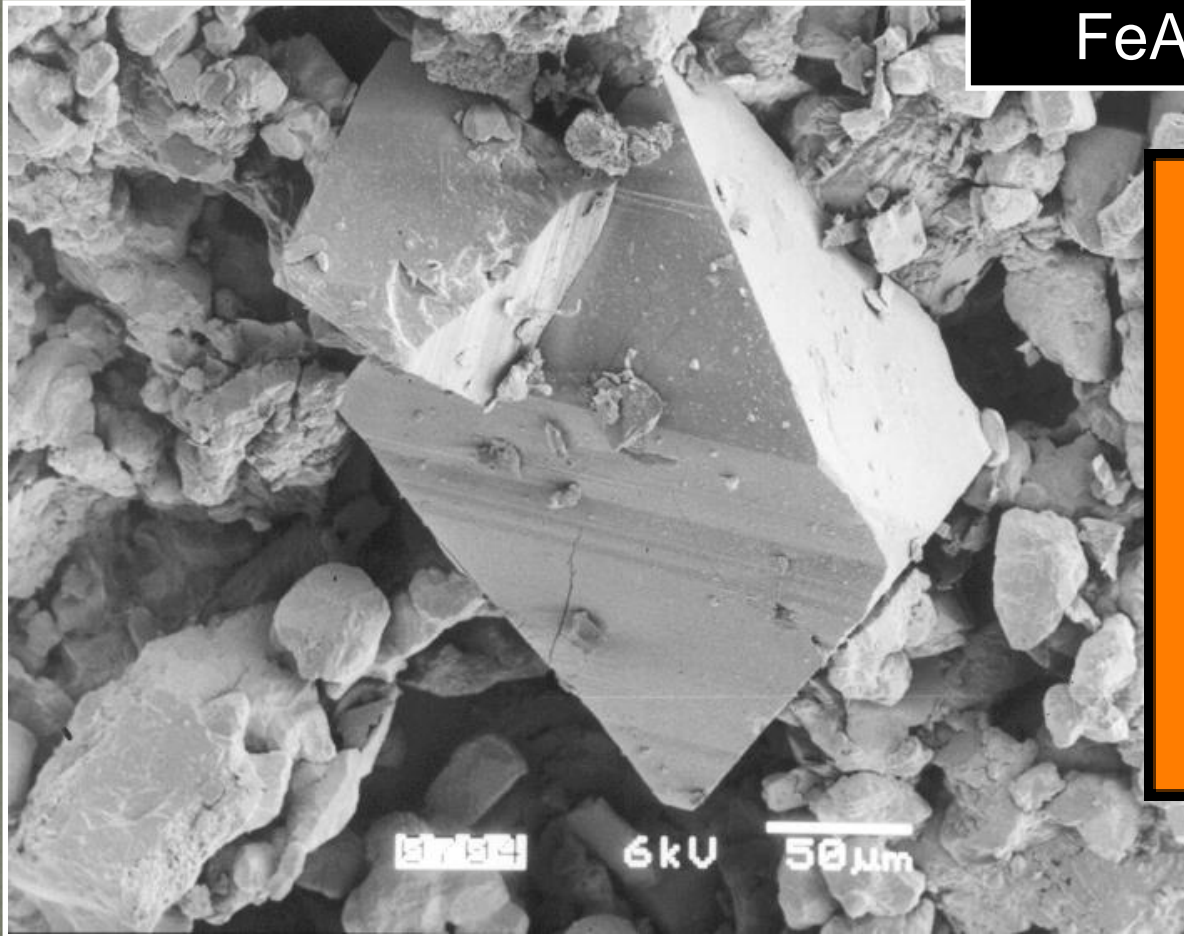


Vantasselite, Bihain

Vantasselite
 $\text{Al}_4(\text{PO}_4)_3(\text{OH})_3 \cdot 9\text{H}_2\text{O}$

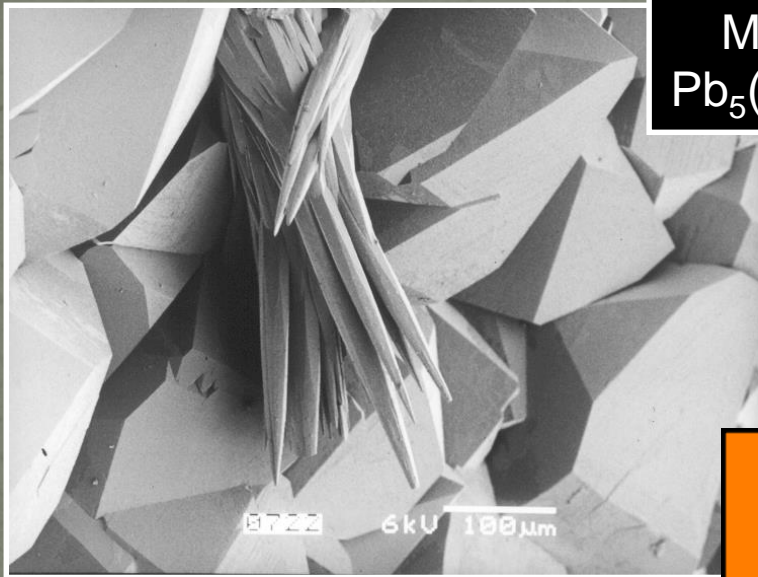
Les arséniates de Hourt

Arsénopyrite
 FeAsS

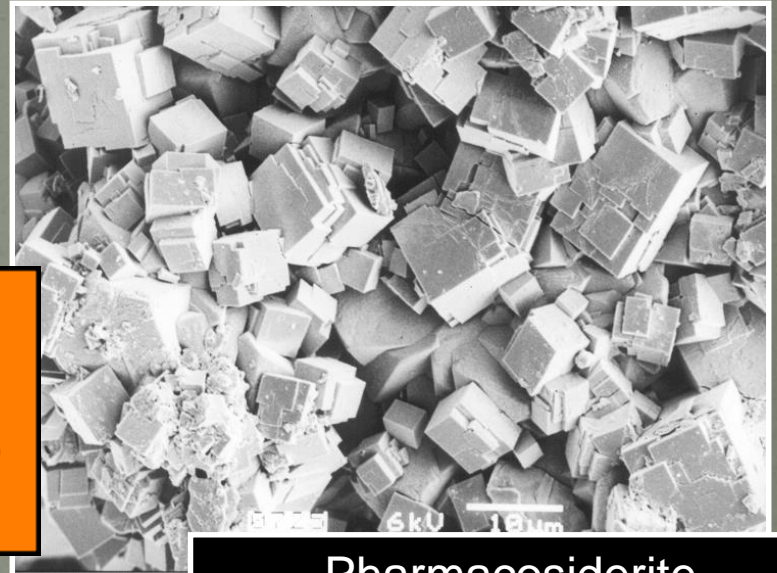


!!! Minéral toxique ☹️ ☹️ ☹️

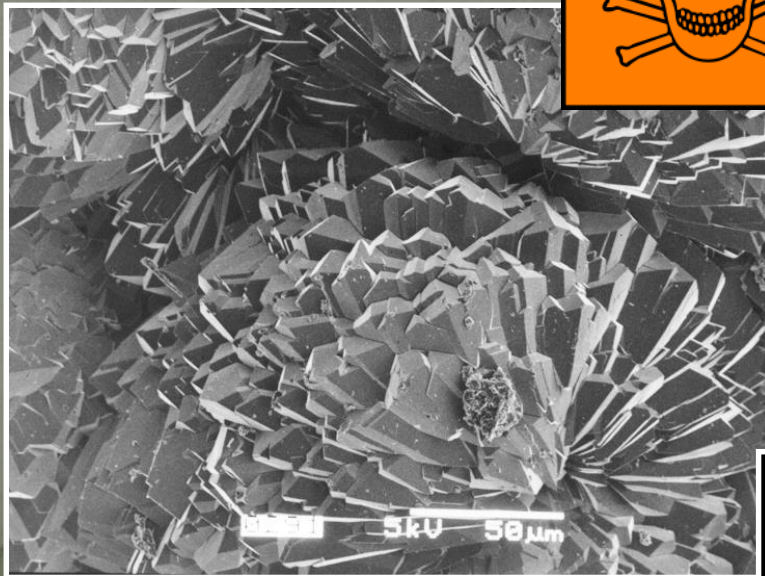
Les arséniates de Hourt



Mimetite
 $\text{Pb}_5(\text{AsO}_4)_3\text{Cl}$



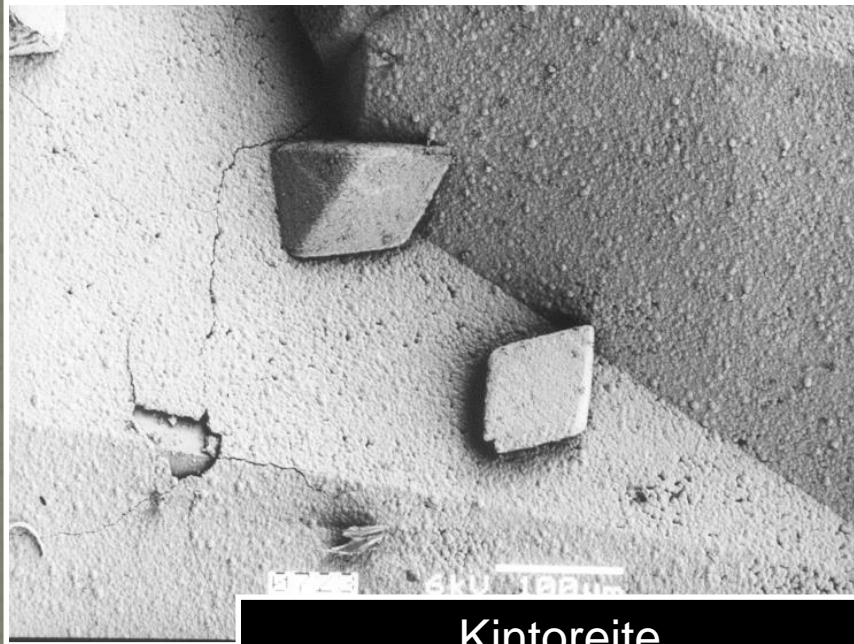
Pharmacosiderite
 $\text{KFe}^{3+}_4(\text{AsO}_4)_3(\text{OH})_4 \cdot 6-7\text{H}_2\text{O}$



Scorodite
 $\text{FeAsO}_4 \cdot 2\text{H}_2\text{O}$

!!! Minéraux toxiques ☹️ !!!

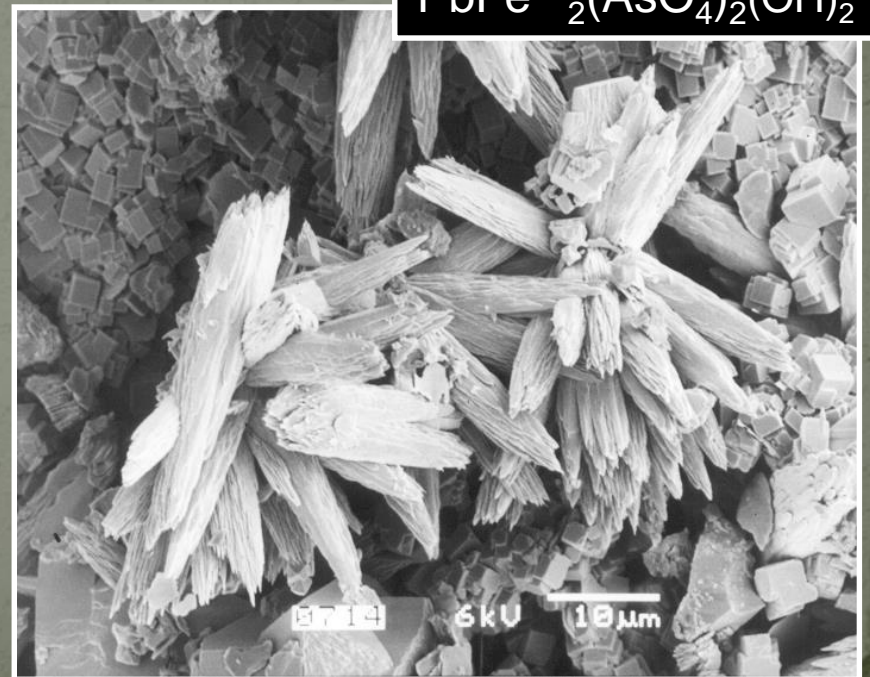
Les arséniates de Hourt



Kintoreite
 $\text{PbFe}^{3+}_3(\text{PO}_4)(\text{PO}_3\text{OH})(\text{OH})_6$



Carminite
 $\text{PbFe}^{3+}_2(\text{AsO}_4)_2(\text{OH})_2$

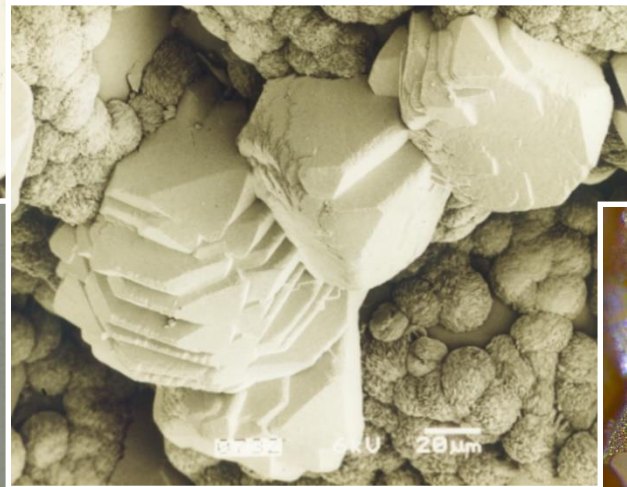
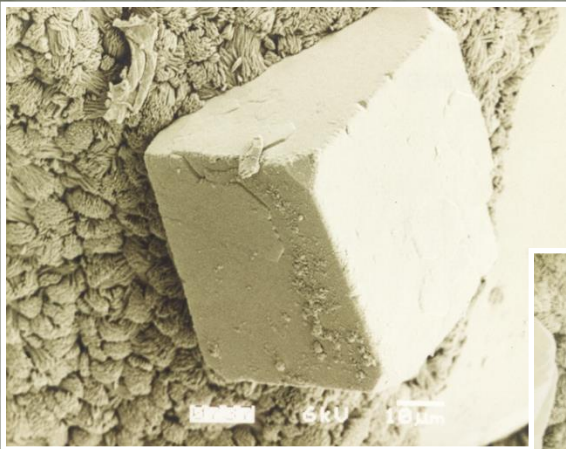


!!! Minéraux toxiques ☹️ ☠️

Les arséniates de Hourt

Graulichite-(Ce)
 $(\text{Ce,La,Nd,Ba})(\text{Fe}^{3+},\text{Al})_3(\text{AsO}_4)_2(\text{OH})_6$

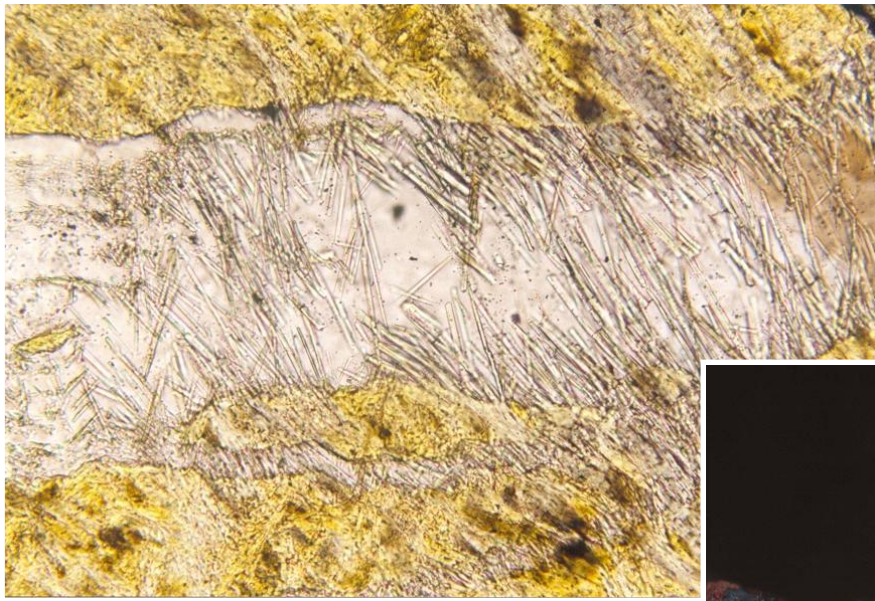
Jean-Marie Graulich
(1920-2001)
Géologue, Liège et
Bruxelles



!!! Nouvelle espèce 😊 !!!



La vallée de la Lienne



Carpholite
 $\text{MnAl}_2\text{Si}_2\text{O}_6(\text{OH})_4$

$T = 300^\circ\text{C}$
 $P = 1\text{-}2 \text{ kbar}$
(Theye *et al.* 1996)



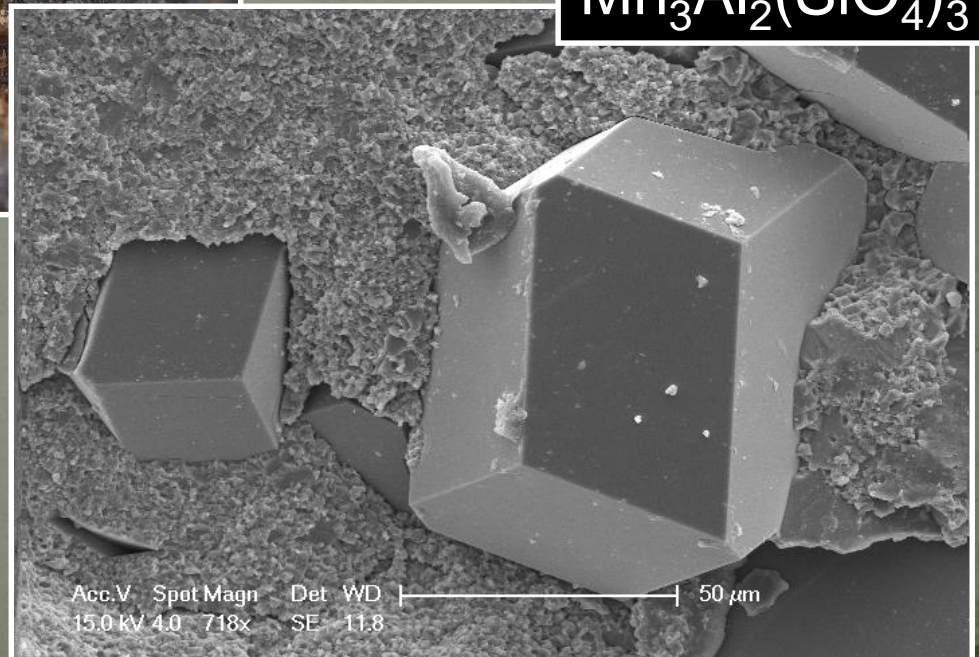
!!! Minéral utile pour les géologues ☺ iii

La vallée de la Lienne

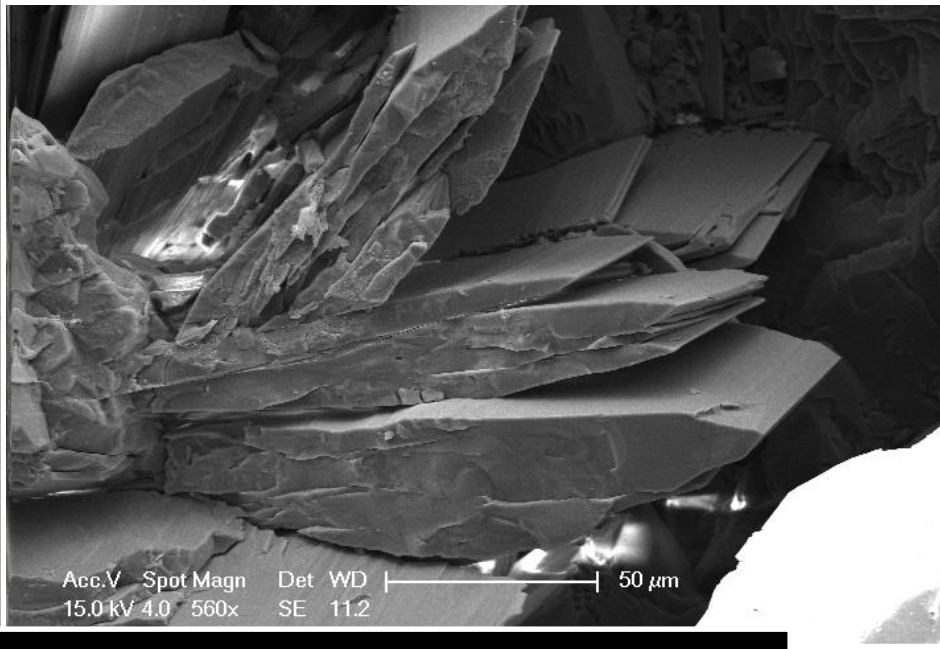


Sursassite
 $\text{Mn}_2\text{Al}_3(\text{SiO}_4)(\text{Si}_2\text{O}_7)(\text{OH})_3$

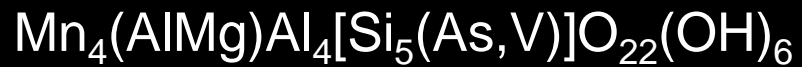
Spessartine
 $\text{Mn}_3\text{Al}_2(\text{SiO}_4)_3$



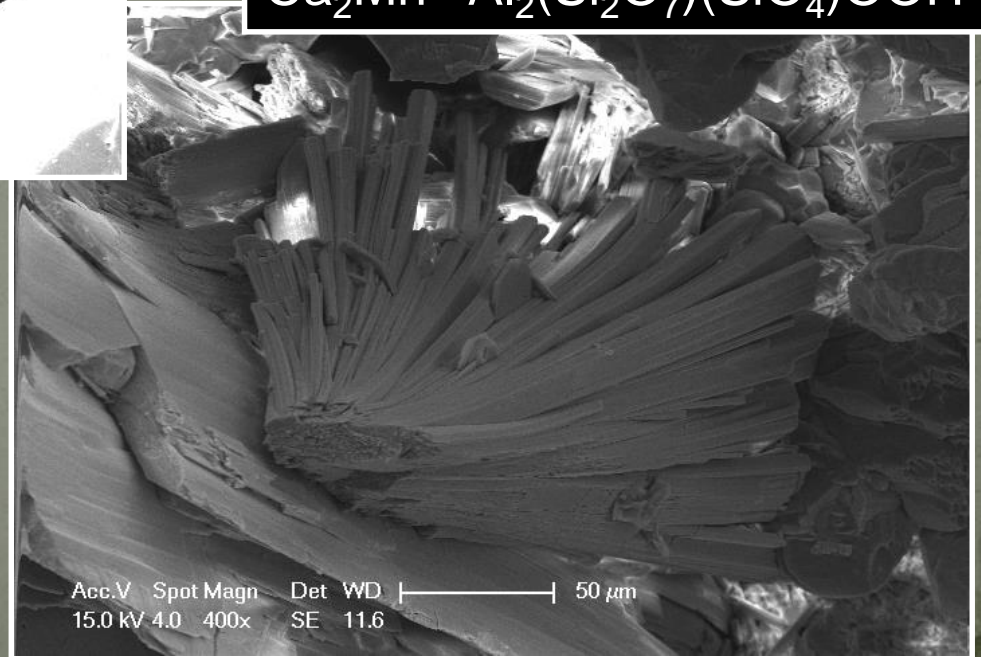
La vallée de la Lienne



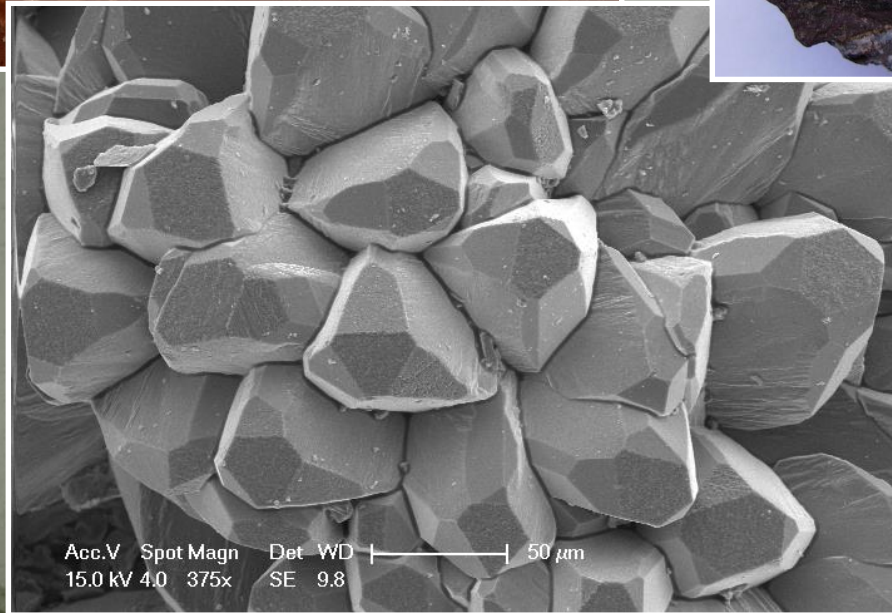
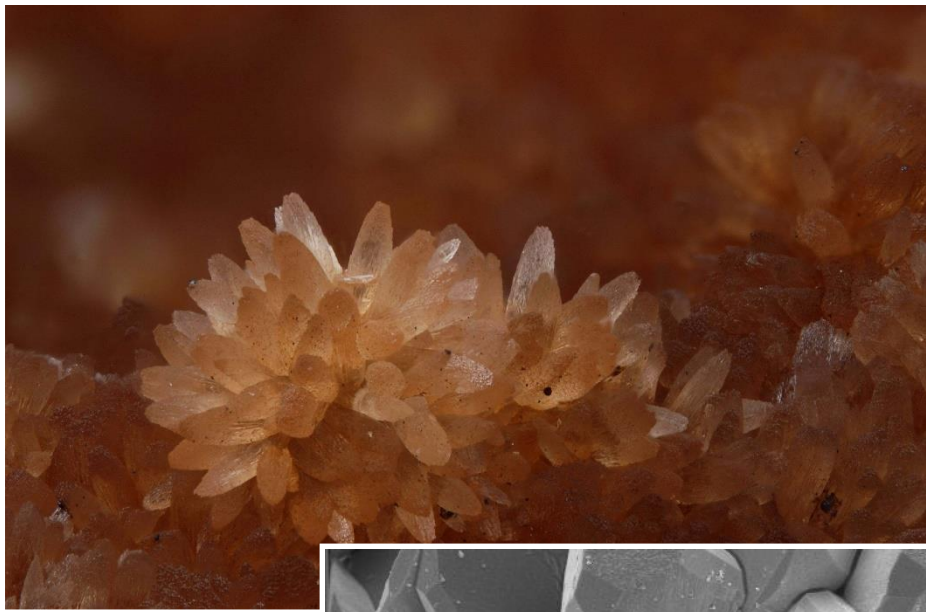
Ardennite



Piemontite
 $\text{Ca}_2\text{Mn}^{3+}\text{Al}_2(\text{Si}_2\text{O}_7)(\text{SiO}_4)\text{OOH}$



La vallée de la Lienne



Rhodochrosite
 MnCO_3

La vallée de la Lienne



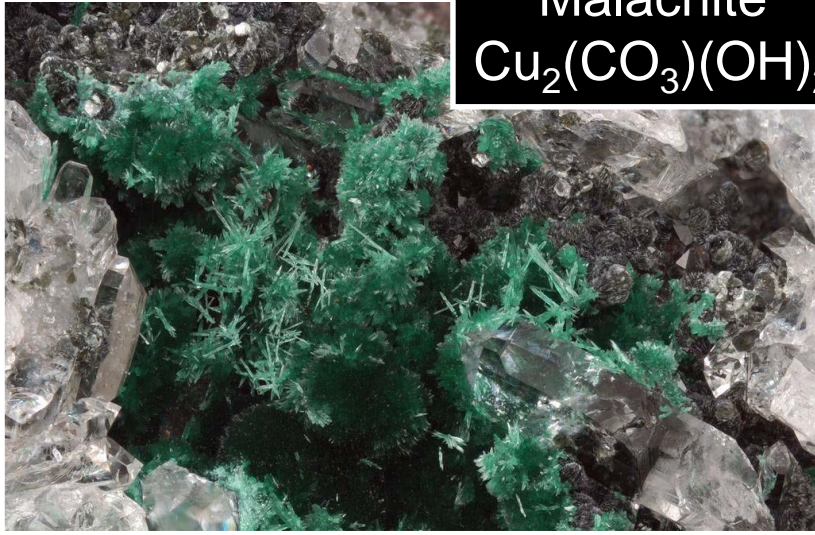
Pyrolusite
 MnO_2



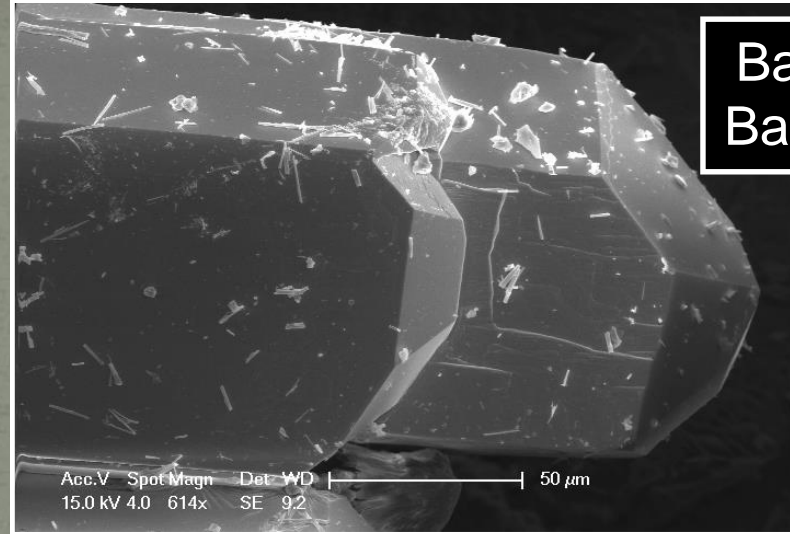
!!! Minéral utile 😊 !!!

La vallée de la Lienne

Malachite
 $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$



Barite
 BaSO_4



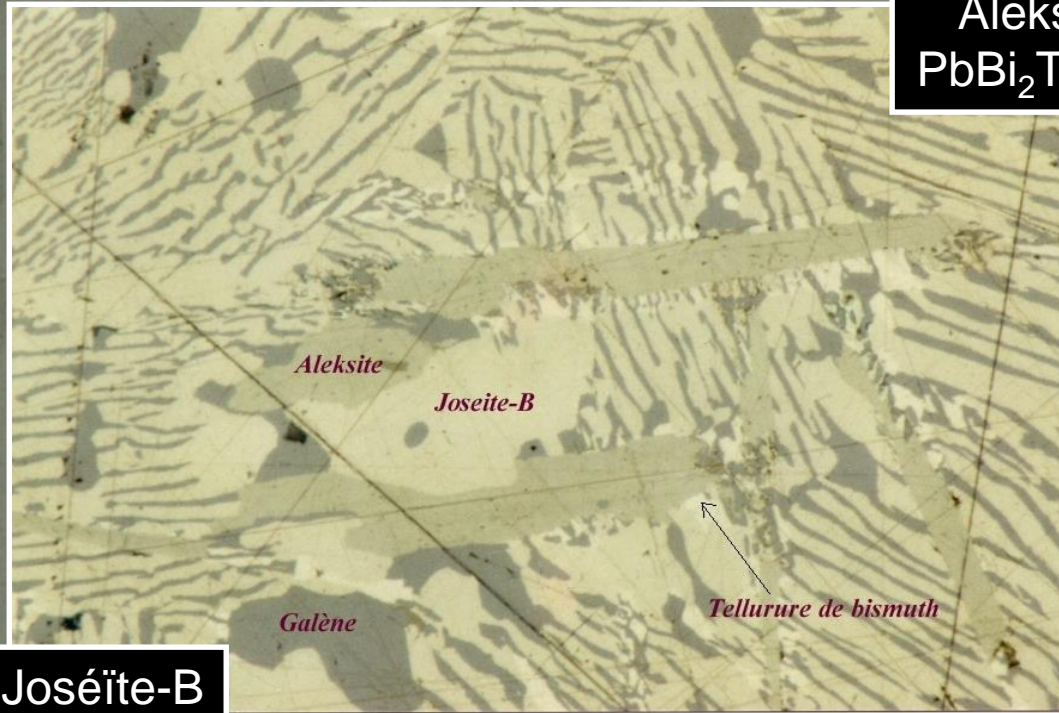
Pyromorphite
 $\text{Pb}_5(\text{PO}_4)_3\text{Cl}$



Azurite
 $\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$



La tonalite de la Helle



Aleksite
 $\text{PbBi}_2\text{Te}_2\text{S}_2$

Joséite-B
 $\text{Bi}_4\text{Te}_2\text{S}$

!!! **Eléments rares** 😊 🍷

Ferrimolybdite
 $\text{Fe}^{3+}_2(\text{MoO}_4)_3 \cdot 8\text{H}_2\text{O}$

