

# Distribution of uranium and thorium in Timahdit's Moroccan black shale

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# Outline

## Context

### Mineralogical characterization of the black shale

SEM, XRD

### Radiochemical analysis of the black shale

Raw material

Results of sequential extractions

## Conclusion



# Introduction

- **Black shales** ⇒ **new adsorbents**

- ⇒ removal of organic substances, heavy metals and bacterium

- ⇒ removal of radionuclides (U ,Th)

- **Radioactive elements more concentrated in black shales than in other sedimentary lithologies**

- ⇒ Release of U, Th into the ecosystem during thermal processing or chemical activation

- **Purpose of the present work:**

- ⇒ **To define the modes of occurrence of U and Th in the raw material.**



# Timahdit's black shale



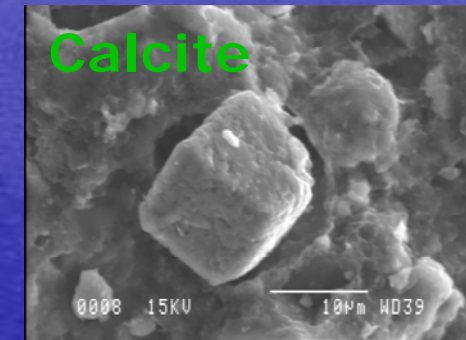
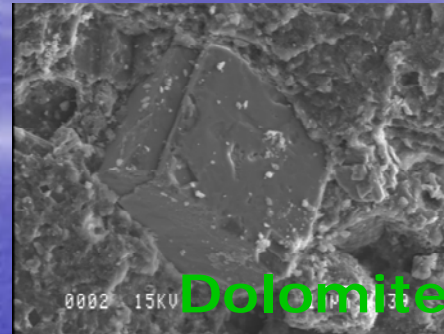
Origin: **the Maastrichtian age**

**This deposit is a vein of schist 100-150 m thick**

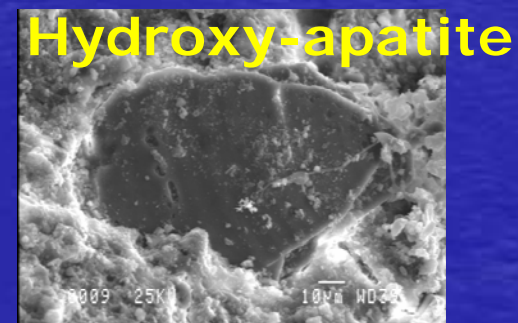
**The studied layer is the richest in organic matter  
(17%: kerogen, humic acids)**

# Mineralogical characterization of the black shale (SEM, XRD)

**Clays** (illite, kaolinite, smectite)

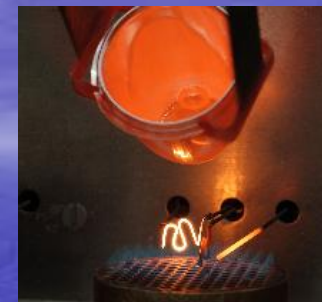
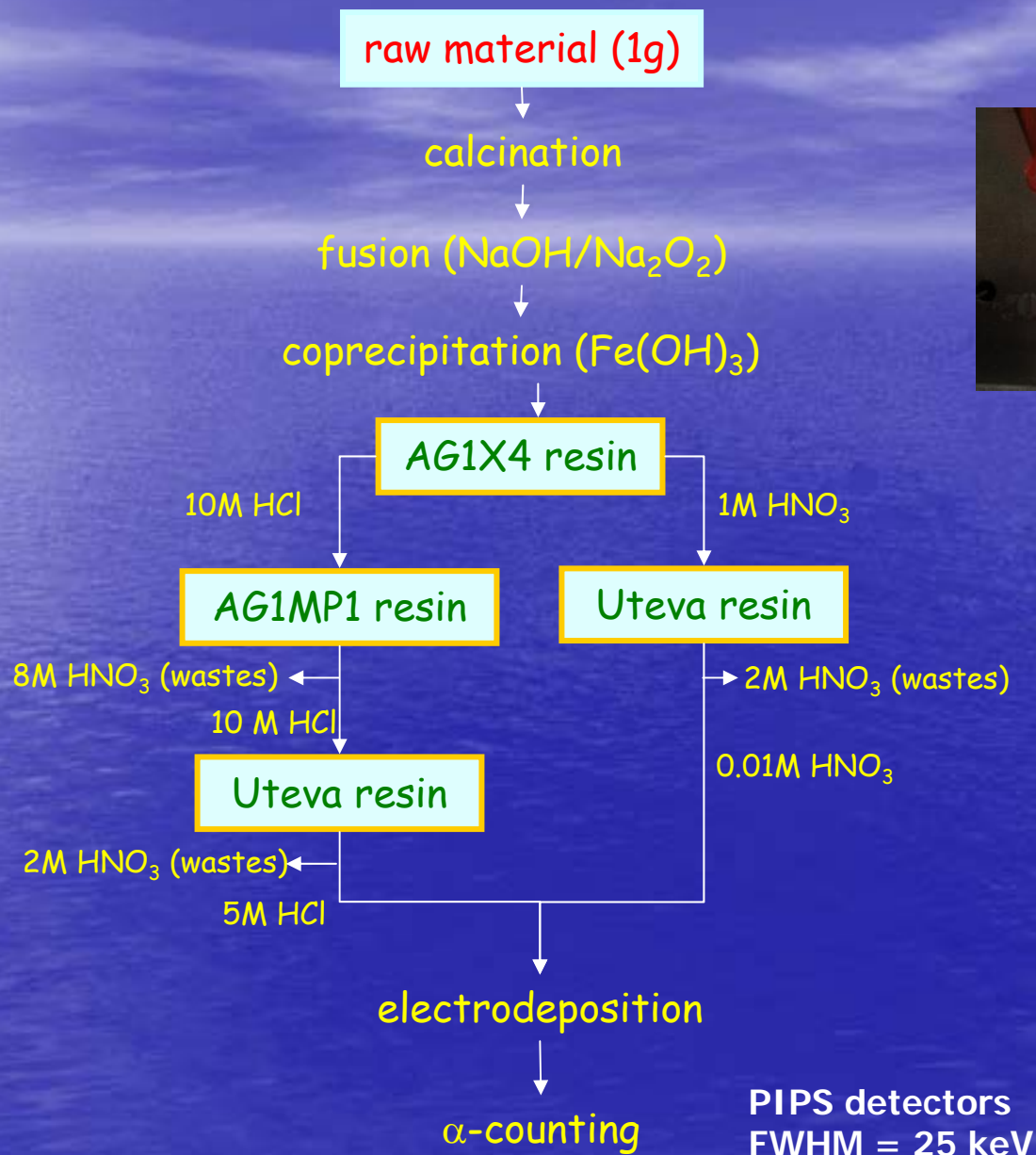


framboidal and euhedral forms

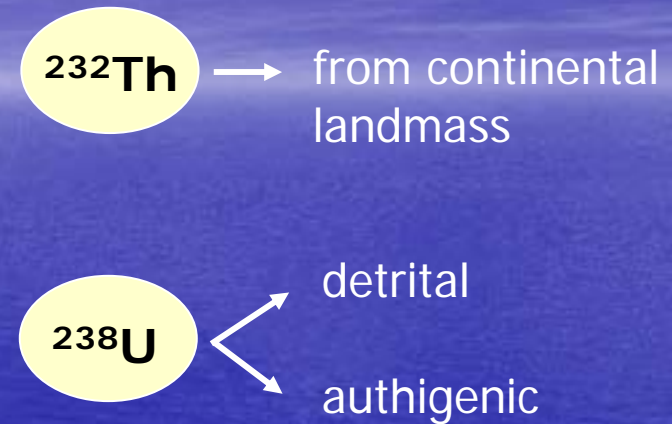
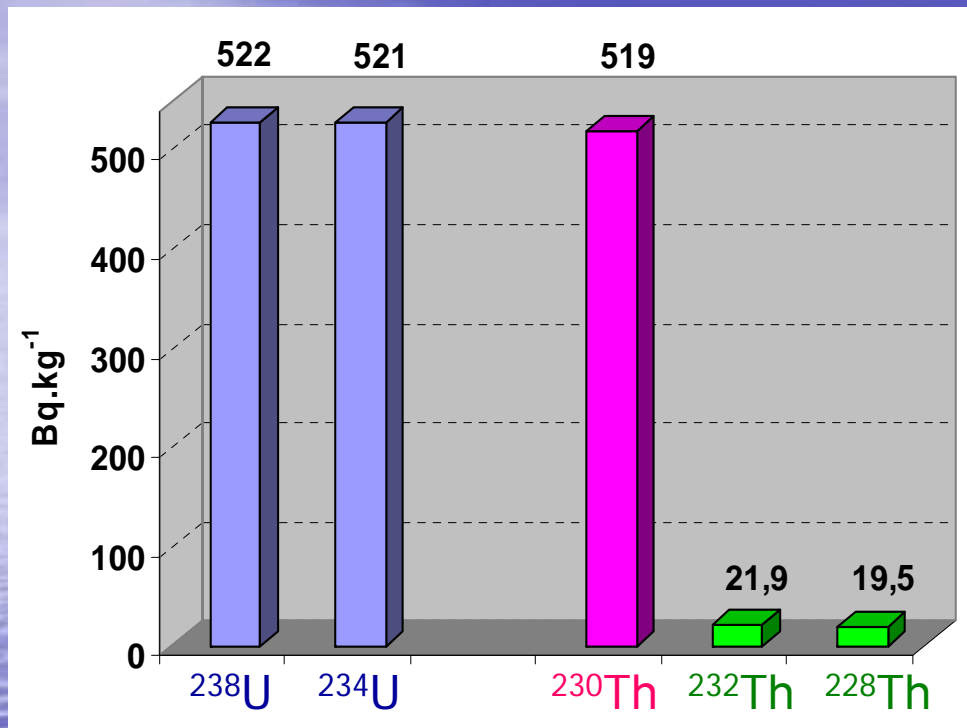


**No iron or manganese oxyhydroxides**

# Radiochemical analysis & Experimental procedure



# Radiochemical analysis of the raw material



## Authigenic uranium:

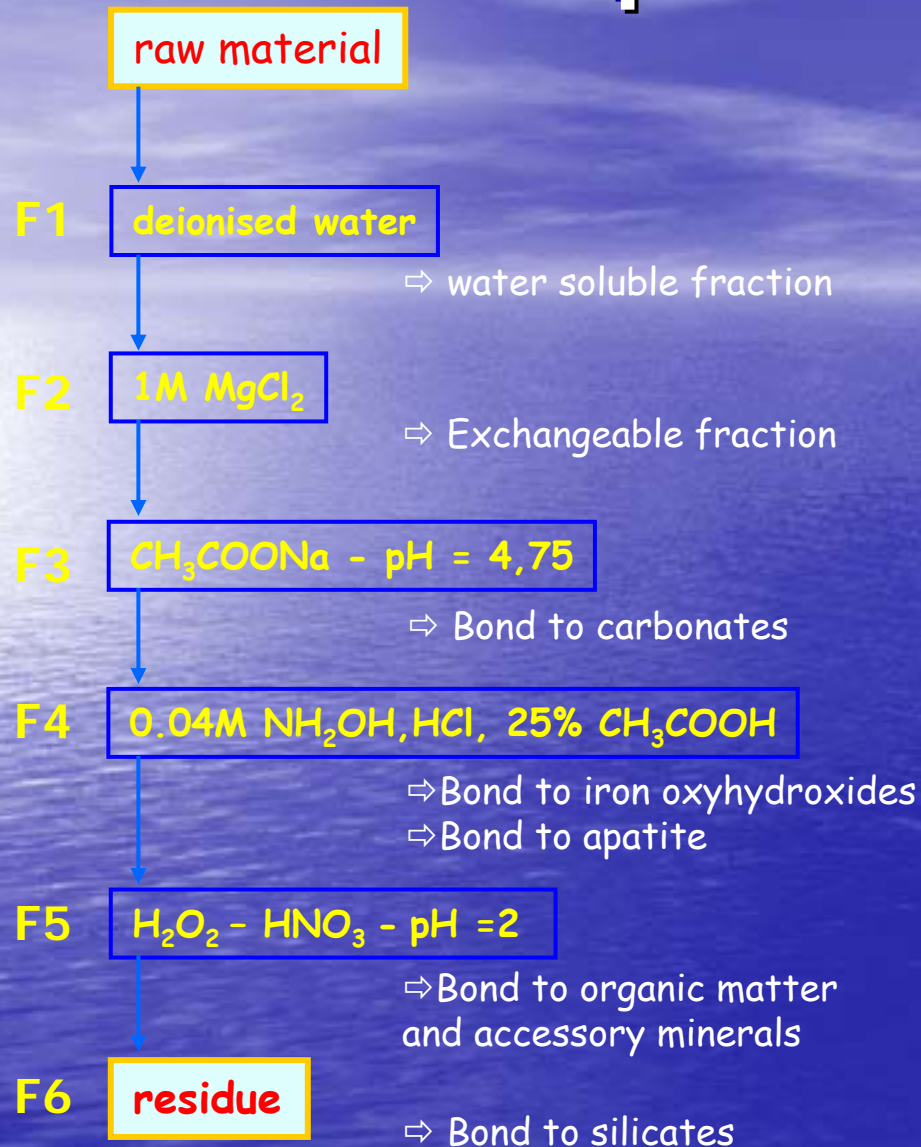
$$[U_a] = [U] - \frac{[Th]}{3}$$

$U_a = 96\%$  of the total uranium

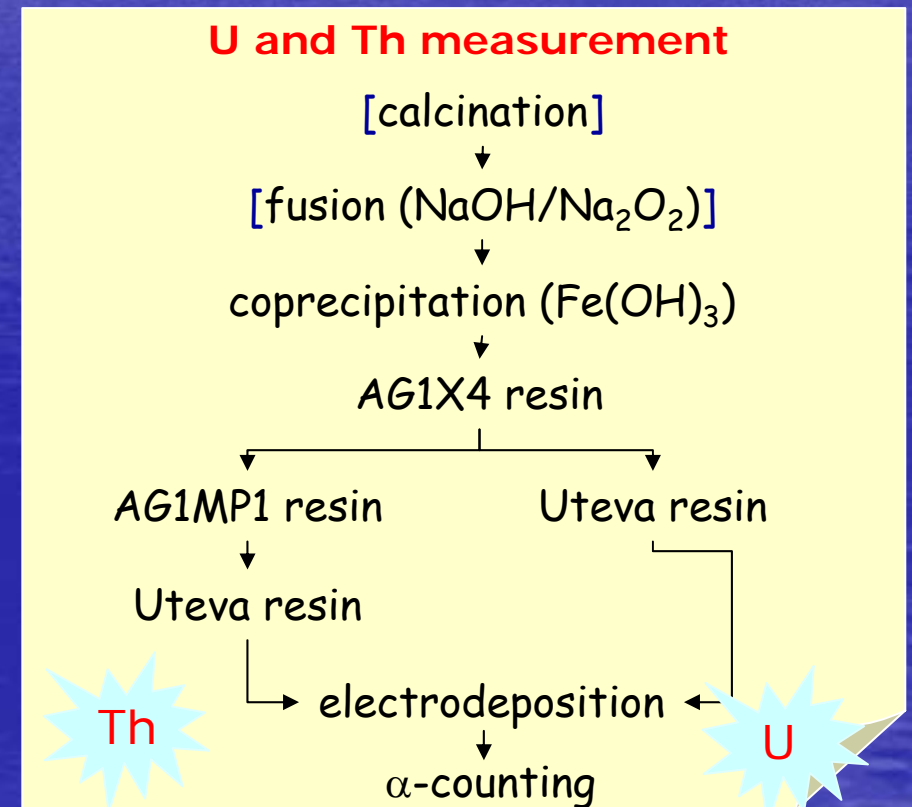
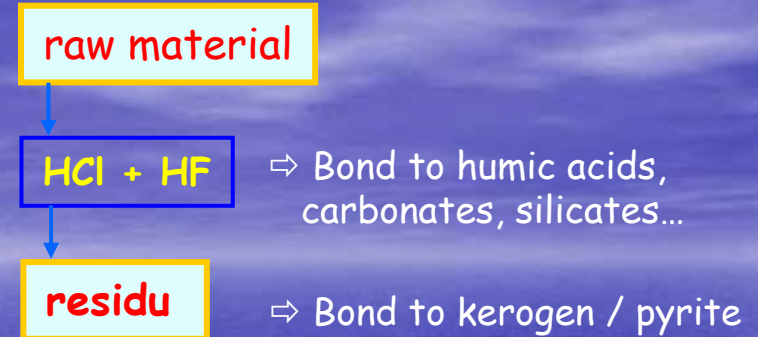
⇒ deposition under reducing conditions

Wignall P.B., Meyers K.J., 1988, *Geology*, 16, 452-455

# Sequential extractions

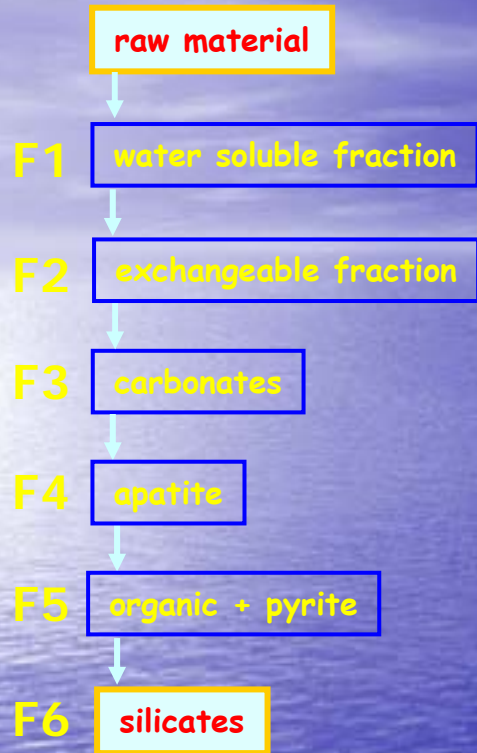


Solid/solution : 1/10

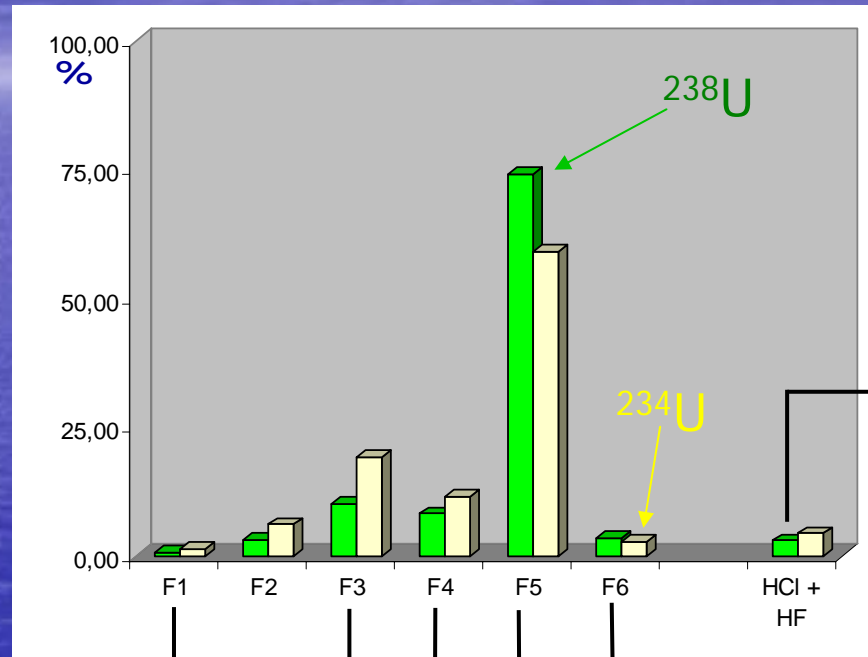




# Results of sequential extractions



Distribution of  $^{238}\text{U}$  in the black shale



kerogen + pyrite : 3%

water-soluble organic complexes : < 1 %

Carbonates : 10%

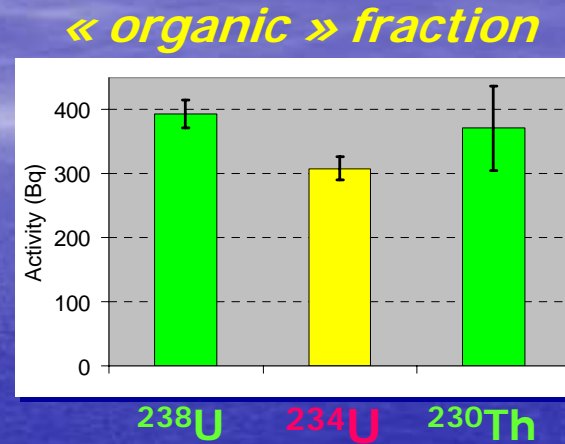
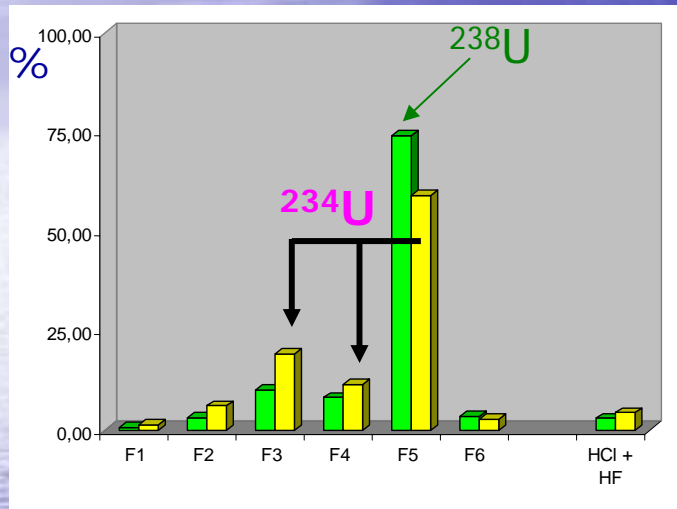
Apatite : 8%

Silicates : 3%

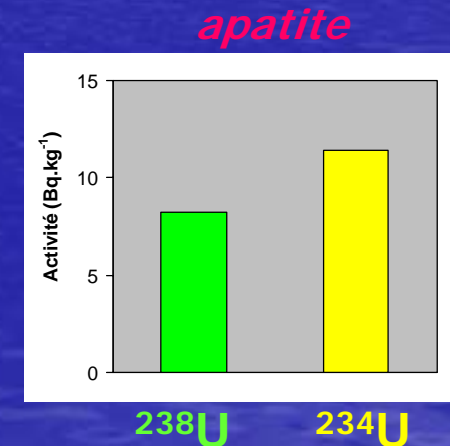
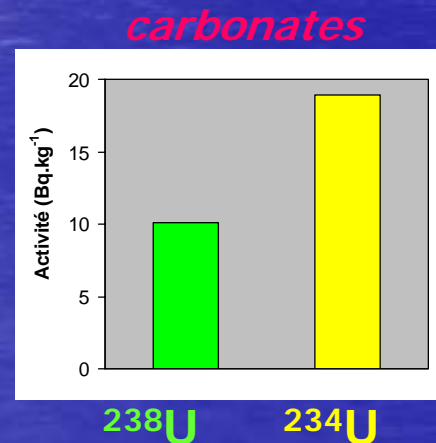
Organic matter (humic acids) : 75 %

# Results of sequential extractions

## Mobilization of $^{234}\text{U}$



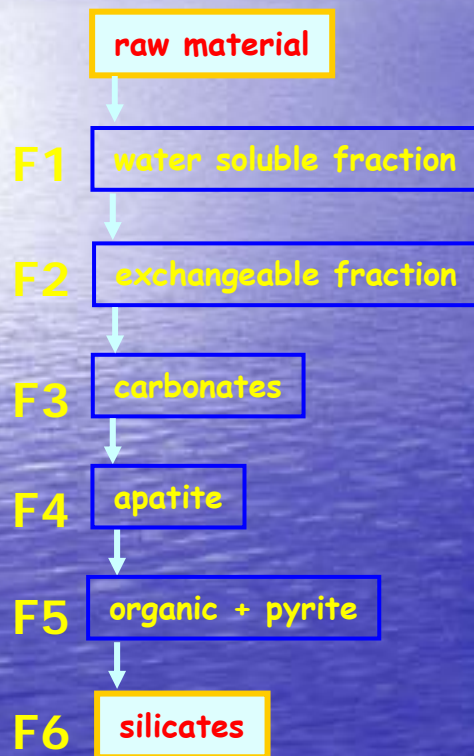
Carbonates  
Apatite



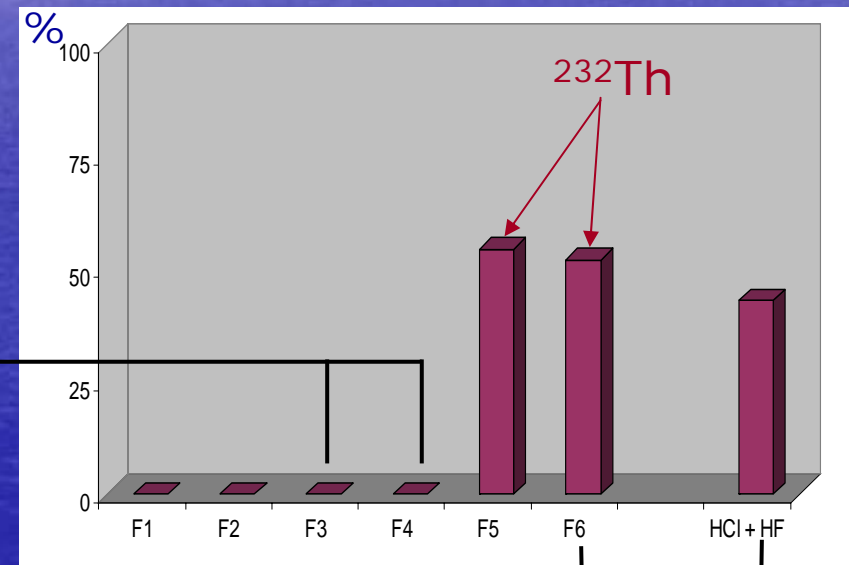
# Results of sequential extractions

## Distribution of $^{232}\text{Th}$ in the black shale

$^{232}\text{Th}$  : detrital input



carbonates,  
apatite :  
 $A_{232\text{Th}} < \text{DL}$



Silicates : 49%

kerogen + accessory  
minerals: 51%

# Conclusion

- ❑ **Characterization of a Timahdit's black shale in terms of  $^{238}\text{U}$ ,  $^{234}\text{U}$ ,  $^{235}\text{U}$ ,  $^{232}\text{Th}$ ,  $^{228}\text{Th}$ ,  $^{230}\text{Th}$  repartition**
- ❑ **Deposition under anoxic environment**
- ❑ **Distribution:**
  - U  $\Rightarrow$  humic acids
  - $^{232}\text{Th}$   $\Rightarrow$  silicate minerals and pyrite
- ❑ **Chemical behaviour of U and Th, alpha decay related processes** are widely responsible for disequilibria in the uranium decay series





*The End*

*With Many Thanks*