University of Anbar
College of Science – Applied Geology Department
Dr. Omar AL-Jarrah
Assis. Professor

4th Stage

Quaternary

Lecture 9: Quaternary Dating – Part 1

Quaternary Dating

Process to determine the ages of Quaternary features

There are Two main methods to do that :

A – Radioactive

B – Process Dating

A - Radioactive : can divide to many types

The radioactive action discovered by Core family

Atomic number (Z) = electron = proton

Atomic weight (A) = proton + neutron

The element have same Z but it different with A called Isotopes . But the element have same A not necessary to have same Z it be different material .

Some element at nature have not steady internal structure so it tend to arrange them selves by losing energy to be more steady and low energy level this called Radio activity .

1 – Alpha α decay : the element throw α particles

α particles = 2P + 2 N same He

Z decrease by 2

A decrease by 4

Most famous element is Uranium change to lead at the end of action .

2 – Beta ß decay : the element throw electron from Atom so he change to proton

Z increase by 1

A the same stable

Most famous element is Rubidium 87

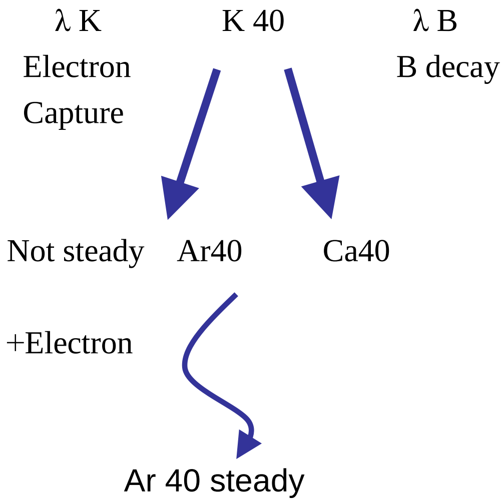
3 – Electron capture ((K capture)) : the atom take an electron from material beside , when this electron enter the structure one of proton change to neutron so

A the same steady

Z decrease by 1

Most famous element is Tritium change to Atrium

4 – Branching decay : some element decay by more than one way . Exp : K40 decay with 2 or 3 above



Each branch separated and independent from the other

and theoretically $\lambda = \lambda 1 + \lambda 2 + \lambda 3 + \lambda 4$ …………

$$\text{Branching ratio} = \frac{\lambda 1}{\lambda 2}$$

5 – Series decay : some materials give a not steady element so this new one will decay again to another not steady element and this will continue till we reach steady elements .

Th 232 → Pb 208 6 α + 4 ß

U 238 → Pb 206 8 α + 6 ß

There are some periods the atoms decay by fixed ratio called decay constant λ. At geological application if some rock isolate from field place and have active element , after while if we measure it to know how many steady element and non steady element become in it , that can help to know the age of that rock by knowing the decay constant and the period to measure and number of N of atoms .

Half life = it's the period to change half quantity of element from active to steady , so the relation

N / No = 0.5

And with another equation $T_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{\lambda}$

<u>The important notes to calculate the Ages of rocks</u>

1 – we must have guarantee than not any adding or losing of the rock material happened to the rock which we dissolved .

2 – we must know λ exactly for the rock , and this λ must be fix within the time of calculations

3 – The sample we calculate must represent all the rock

4 – No contamination may happened during the changing

5 – The procedure of calculation must be with high accuracy .

6 – Not all methods of calculating useful at determine the Ages because of short or long half life .

B – Process Dating

First : radiocarbon dating

The natural carbon is C14 , there is action at atmosphere Product Neutron by the effect of Cosmic Ray and still formed there by the oxidized of O2 and change to CO2 and enter in the plant and animal bodies or any other material have C in the formation .

The carbon have 3 isotopes

C12 the rate at Atmosphere 98.89 %

C 13 the rate at Atmosphere 1.11 %

C 14 the rate at Atmosphere 1 part of 1000000000000

When the animal or plant die the operation of exchange with the atmosphere stop so the steady C12 will stay at his rate but the unstable C14 will decay to ß + N14 , by the time if we know how match the half life of C14 and N14 we can calculate the Age of the material . The half life of C14 is 5400 ± 200 year .

By analysis the wood – peat – caco3 – food – bones we can know the old of things .

The maximum age of that procedure about 50000 year because of short half life of C14 .

Second : Uranium series (disequilibrium methods)

Series of decay operations will change the Uranium to lead .

U 238 → Pb 206

U 235 → Pb 207

Some half life very short (seconds or mile seconds) so its not useful but the others half life very useful to Quaternary .

U 234 to U 238 250.000 year

U 235 to Pb 32.000 year

The most positive point at this methods is the decay begin at zero level in side animal body when he die and no effect of environment around him .

This method apply at deep seas and oceans . And the problem by

Diogenesis movement that can effect the samples at sediments , so that chose of samples must done by very high accuracy . To have samples with out Diagentic .

Third : K – Ar methods (Ar40 / Ar39)

Applied generally at igneous rocks and recently at Shale and clay .

K exist naturally at igneous rocks specially acidic one with rate about 10% and less at basic one .

The isotopes of K are : K39 and K41 both stable but K40 not stable with half life 1.3 X 10^9

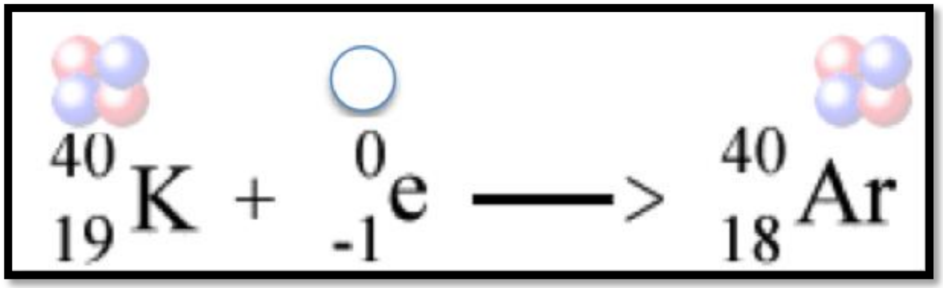
The Ar have also many isotopes : Ar 36 , 38, 40

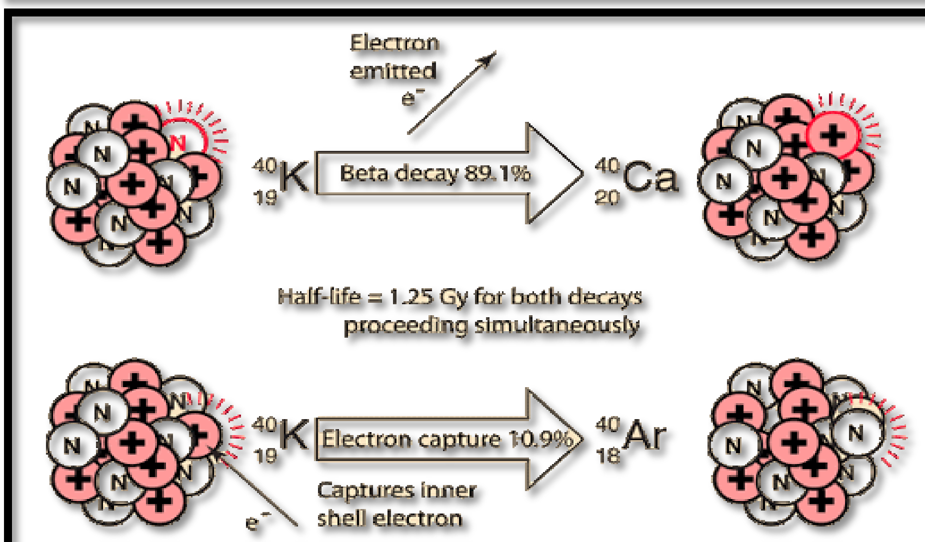
The K very common at nature so we can measure very wide range of rocks contain it , also with very good half life 6000 – 100000 years suitable for many rocks .

so the new forming rocks can not measure by this method . But the Ar not exist at igneous Rocks because of Heat make the Ar Gas ran away , and at sedimentary Rocks it not exist also because of the Erosion and deposition action .

So its very important when we chose the sample of rocks to be present the real Age not the digenesis may effect that .

Exmp : rocks near volcano aperture if the Lava come out the heat may change the age of rocks there and give false Age belonged to lave not to the old rocks .





References

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