Sandstone-hosted uranium deposits of the Huemul district, Argentina, a new uranium deposit model for the western United States

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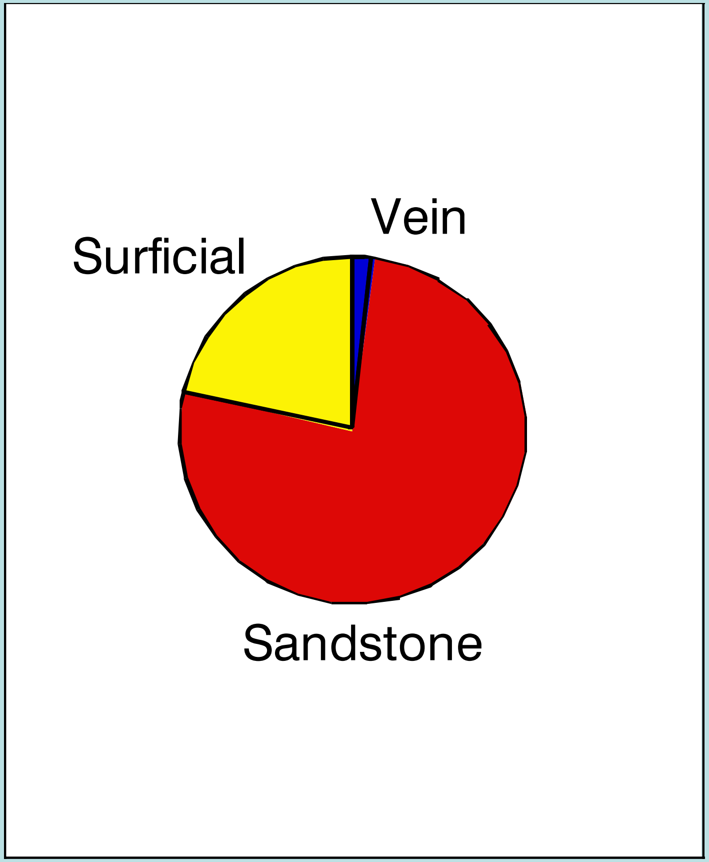
CALYPSO URANIUM

Uranium in Argentina

- Exploration for uranium began in the 1940s
- 2,509 metric tonnes production
- 17,000 metric tonnes reserves and resources (<US$130/kg, Red Book 2003)
- 55,000 metric tonnes U potential resource CNEA (World Nuclear Association)

Uranium deposits in Argentina



(IAEA, Technical Report Series Nº 270)

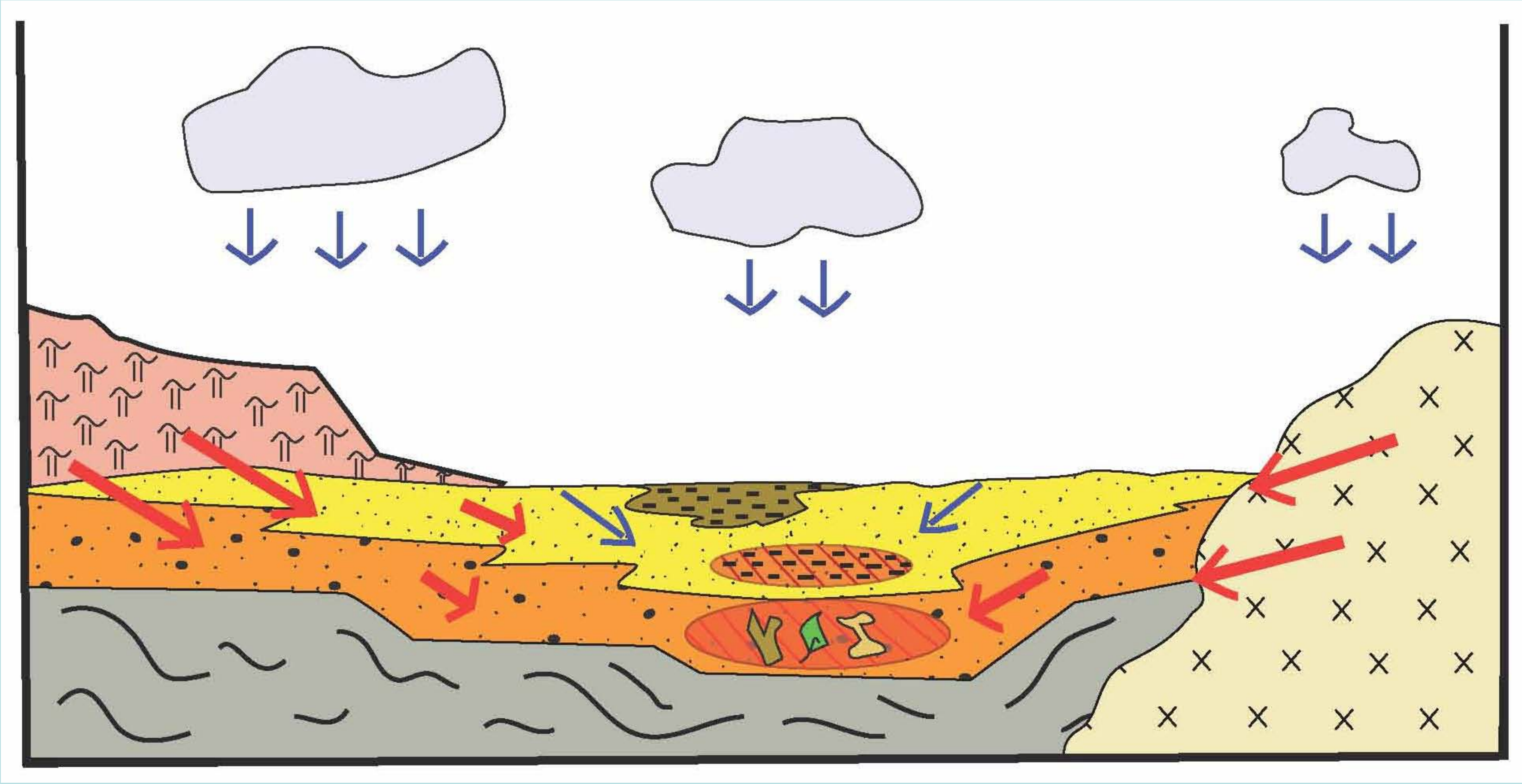
Uranium Deposits in Sedimentary Rocks: Three genetic models

I. Deposited by descending meteoric waters
II. Uranium derived from black shales during generation of hydrocarbons
III. Uranium derived from destruction of accessory minerals from igneous rocks

I. Deposition by descending meteoric waters

- Origin of U: Acidic igneous rocks, predominently pyroclastics, containing between 20ppm U and 100 ppm U (Simov, 1989)
- Liberation of U during devitrification
- Migration in descending meteoric water with high fO_2
- Precipitation by local reductant or reduction of porosity
- Geochemistry: U (+- Mo)
- Example.: Cerro Solo

I. Deposition by descending meteoric waters



II. Uranium derived from black shales during generation of hydrocarbons

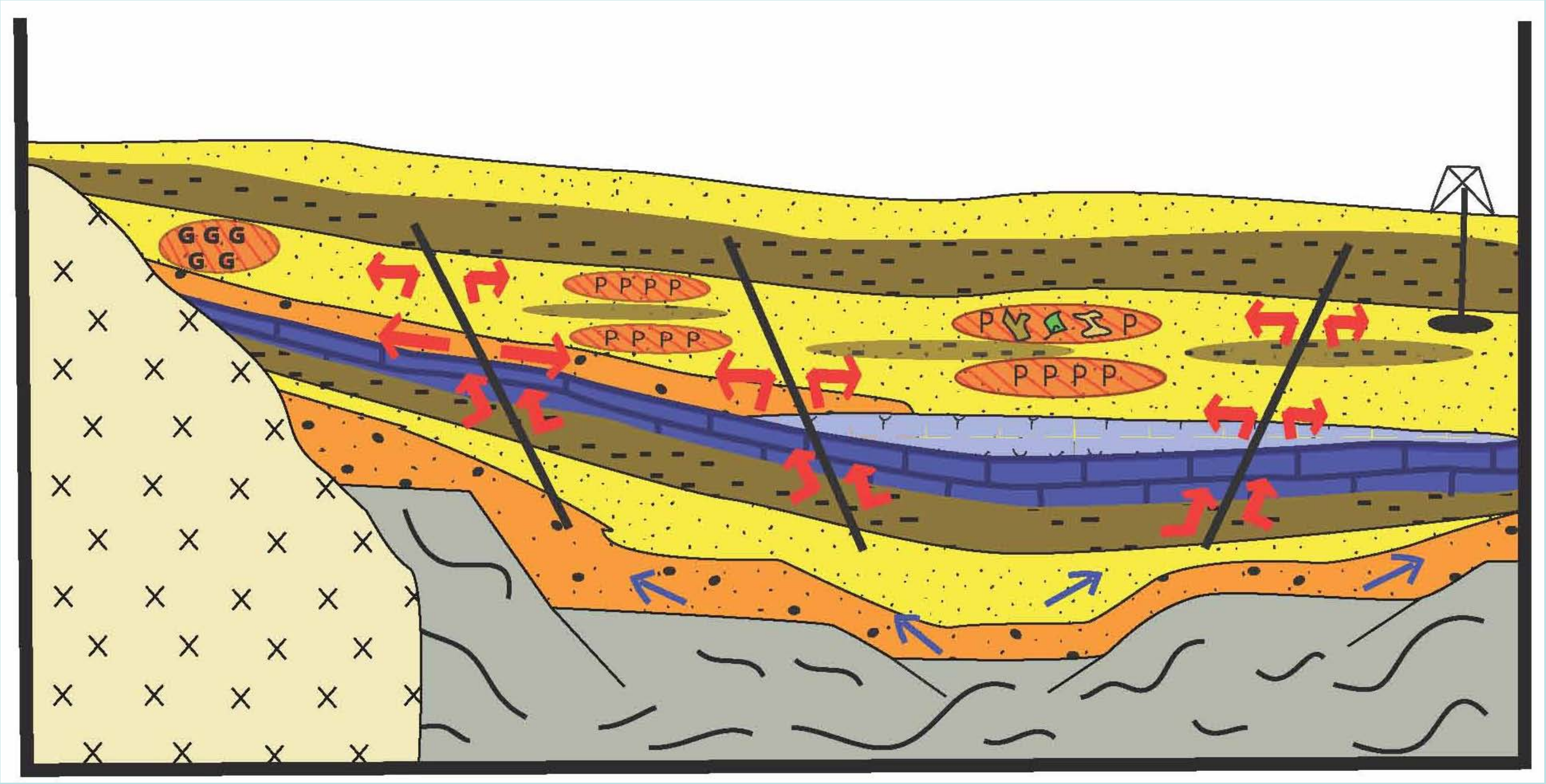
- Source of Uranium: Black shale (Example.: Devonian Ohio Shale, SDO-1)

Element	mg/kg	s.d.	Element	mg/kg	s.d.
As	68.5	8.6	Ni	99.5	9.9
Ba	397	38	Pr	8.9	0.66
Ce	79.3	7.8	Rb	126	3.9
Co	46.8	6.3	Sc	13.2	1.5
Cr	66.4	7.6	Sm	7.7	0.81
Dy	6.0	0.65	Sr	75.1	11.0
Eu	1.6	0.22	U	48.8	6.5
Ga	16.8	1.8	V	160	21
La	38.5	4.4	Y	40.6	6.5
Mo	134	21	Yb	3.4	0.46
Nb	11.4	1.2	Zn	64.1	6.9
Nd	36.6	3.3	Zr	165	24

II. Uranium derived from black shales during generation of hydrocarbons

- Expulsion of uranium in the "petroleum window"
- Lateral migration and rise of acidic Cl-rich brines that bleach and alter rocks
- Precipitation by changes in oxidation-reduction conditions
- Geochemistry: U (+-V,As,Mo,Ni,Cd,Co,Cr)
- *Example.: Don Otto*

II. Uranium derived from black shales during generation of hydrocarbons



III. Uranium derived from the destruction of accessory minerals from igneous rocks

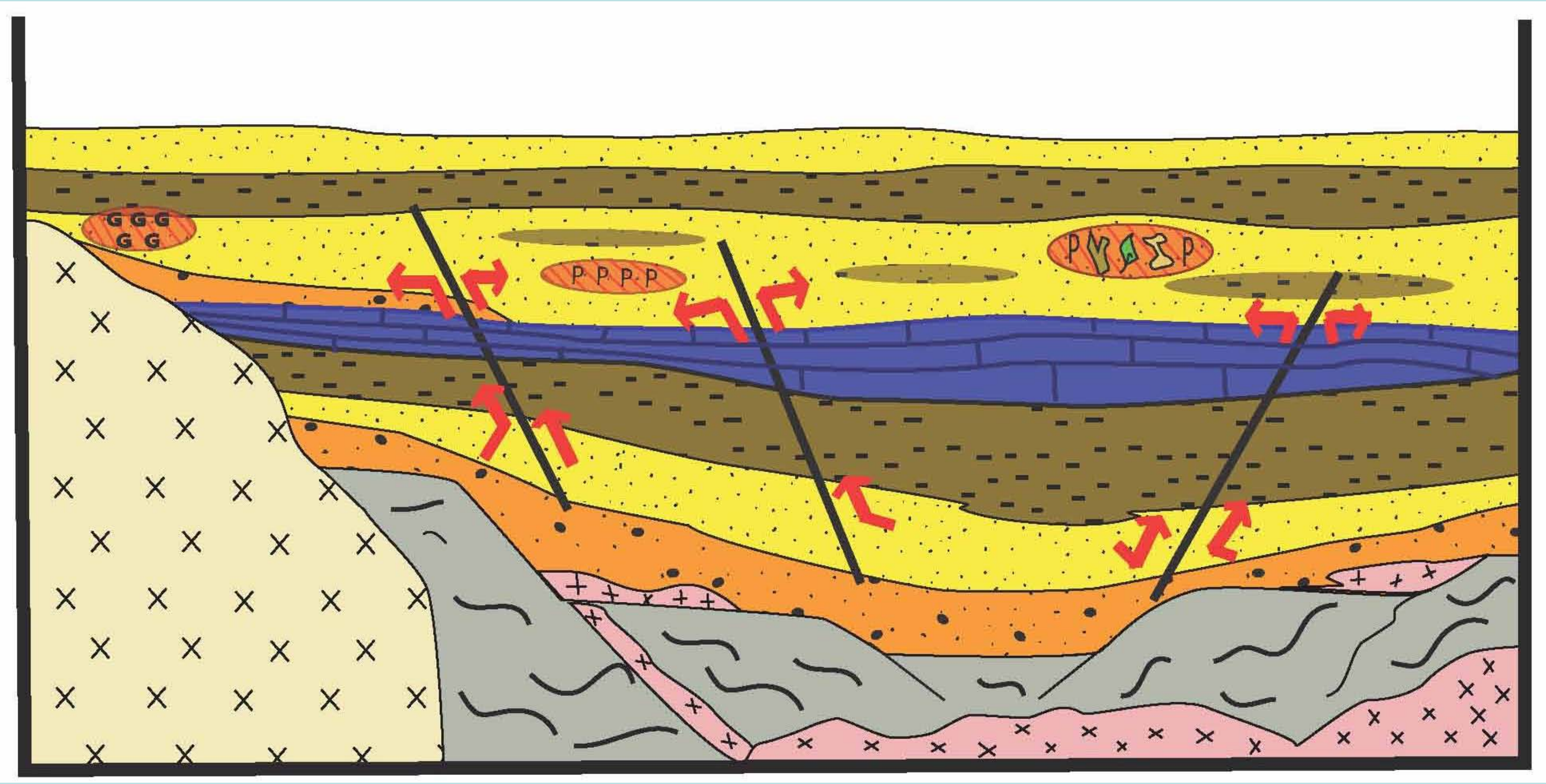
Type of Granite	Accesory minerals		
Peraluminous	Monazite	(Ce,La,Nd,Th)PO4	0.5-3%U
	low Th uraninite	UO2	Th<2-3%
	¨+-Xenotime	YPO4	
	¨+-Zircon	ZrSiO4	
	¨+-Apatite	Ca5(PO4)3(OH,F,Cl)	<0.2%U
High-Ca	Titanite	Ca5(PO4)3(OH,F,Cl)	REE <4%
Meta-aluminous	Thorite	(Th,U)SiO4	up to 15%U
	Amphibole (+-Pyroxene,Zircon,Apatite)		(+-Th rich uraninite)
	Titanite, allanite (+-Th rich uraninite, uranothorite)		
Peralkaline	Zirco, Nb-Ta-Ti oxides		

from Cathelineu et al, 1989

III. Uranium derived from the destruction of accessory minerals from igneous rocks

- Erosion of acidic ingeous rocks into a basin with anomalous geothermal gradient
- Destruction of monazite and other accessories above 200°C
- Lateral migration and rise of acidic Cl-rich brines that bleach and alter rocks
- Precipitation by changes in oxidation-reduction conditions
- Geochemistry: U (+-REE,Y,Th)
- *Example.: Huemul*

III. Uranium derived from the destruction of accessory minerals from igneous rocks



Pathfinder Geochemistry in Argentina Uranium Exploration

Cuenca	Modelo Propuesto	Ag PPM	As PPM	Cd PPM	Ce PPM	Co PPM	Cr PPM	Cu PPM	Ga PPM	La PPM
San Jorge	I	<0.5	54	<1	45	7	8	30	6	27
Gondwánica	II	2.7	470	99	54	34	72	53	<2	102
Neuquina	III	115.4	318	<10	493	67	34	54865	107	65

Cuenca	Modelo Propuesto	Mo PPM	Ni PPM	P PPM	Pb PPM	Th PPM	U PPM	V PPM	Y PPM	Zn PPM
San Jorge	I	19	5	>10000	66	<10	952	89	95	57
Gondwánica	II	40	85	838	>10000	250	>10000	73	26	446
Neuquina	III	15	34	454	507	241	16431	25516	260	512

Huemul District, Argentina bitumen saturated sandstone

Huemul District, Argentina open cut in mine outcrop

Huemul Distict production

550,000 # U3O8 average grade probably about 0.3% U3O8

Huemul District, Argentina bitumen saturated sandstone with uranium

Lisbon Valley Uranium District

- SE Utah, San Juan County,
- Lisbon Valley anticline, salt cored
- 80 million pounds U_3O_8 production 1953-1984
- Basal Triassic Chinle Fm. conglomerate and upper Permian Cutler Fm. Sandstone
- Geochemistry U +/- V, As, Co, Cr, Cu,

Lisbon Valley District, Utah
bitumen saturated sandstone

LV 4C3 395 to 433 - bitumen impregnated sandstone and conglomerate
Basal Chinle Fm. (contact with Cutler at 425 ft)

Lisbon Valley District, Utah Cutler Fm. dune facies sandstone with bitumen and uranium

LV 4C3 559 to 612 ft, (575 ft to 585 ft, bleached fine-grained sandstone with bands of bitumen assayed 155 ppm U)

US Uranium Districts associated with hydrocarbons

- Lisbon Valley, Utah - bitumen
- San Rafael Swell, Utah - bitumen
- La Sal, Utah and Colorado -bitumen
- Uravan, Colorado - bitumen
- Gas Hills, Wyoming - natural gas
- South Texas - natural gas