



7th International Conference on Raman Spectroscopy
Applied to the Earth and Planetary Sciences

June 4-7th, 2006

ALMUÑECAR, (Granada-SPAIN)

Field Trip: Early Martian analogue RIOTINTO

3rd and 4th June, 2006



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3rd June : Leave Almuñécar by bus at 8h from "[Jose María García Sports Pavilion](#)", arriving to Nerva (Huelva) at 14h.

Accommodation and lunch at Nerva, in "Vazquez Díaz hotel".

Field trip to Río Tinto source, 16h to 20h.

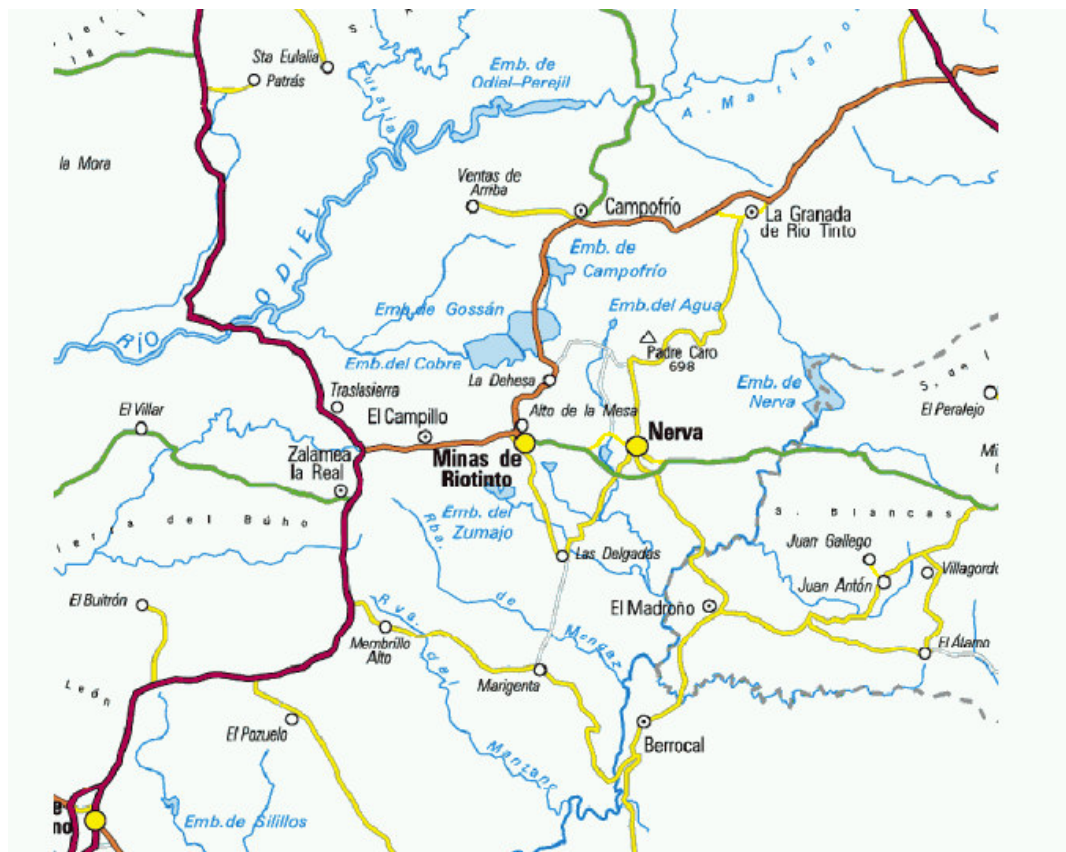
Return to Nerva hotel for dinner at 21h.

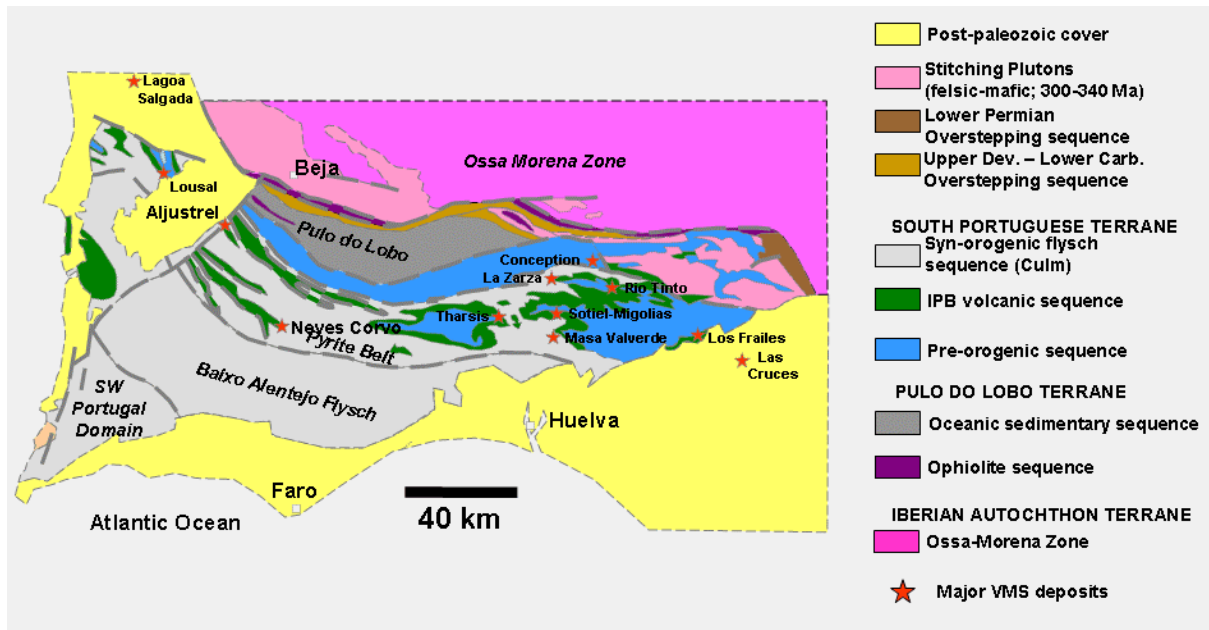
4th June : Visit to Mining Museum of Río Tinto, at 11h.

Trip along river by train, 13.30h to 15h.

Lunch in "Vazquez Díaz hotel", at 15.30h.

Leave Nerva hotel at 17h, arriving to Almuñécar at 23h.



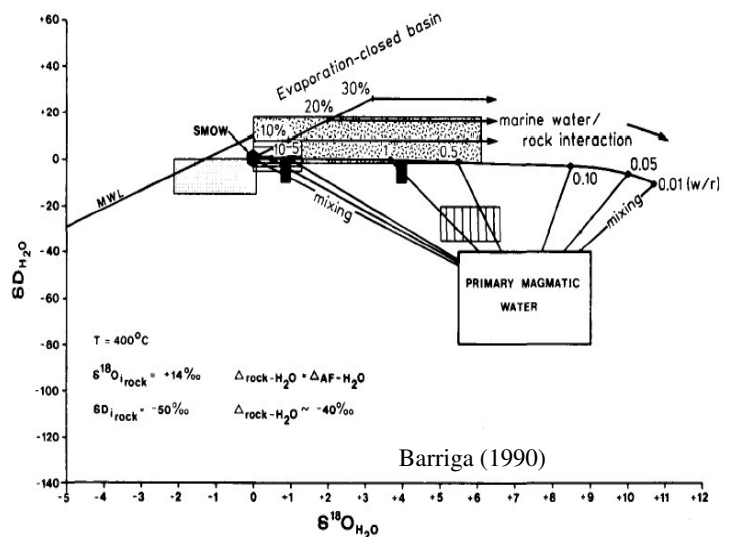


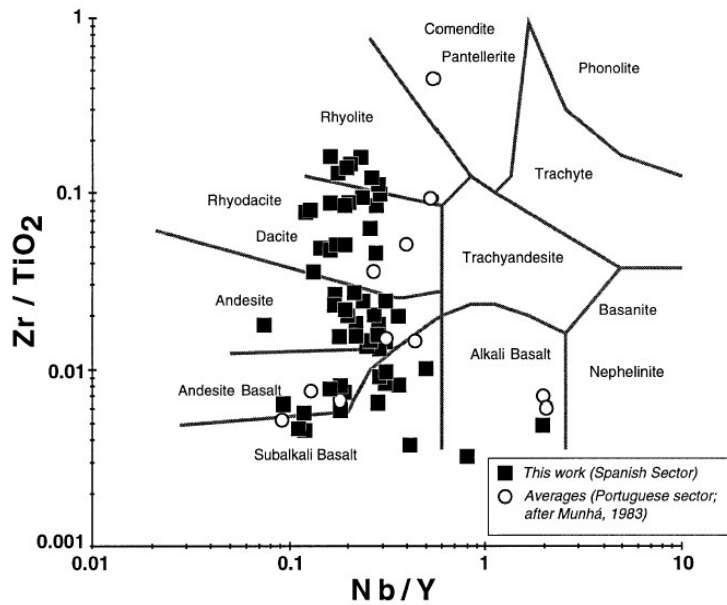
Reserves of massive sulphide ore in the IPB presently amount to about 700 Mt (megatonnes), essentially concentrated at seven major locations (Fig. 11): (Aljustrel (250 Mt) and Neves-Corvo (130 Mt) in Portugal, and Tharsis (130 Mt), La Zarza (60 Mt), Rio Tinto (55 Mt), Aznalcollar (50 Mt) and Sotiel (40 Mt) in Spain. Other mines, exhausted or nearly exhausted, which were important in the past, include S. Domingos (30 Mt) and Lousal (20 Mt?). A very large part of these reserves (which do not include stockwork-type ores) were discovered after the early 1960s, as a consequence of widespread acceptance of the exhalative-sedimentary theory of ore genesis (Ofstedhal 1958), originally advocated by Klockman (1894), eloquently illustrating the importance of correct geological understanding and models in mineral exploration (Strauss et al. 1977; Carvalho 1979).

Barriga (1990)

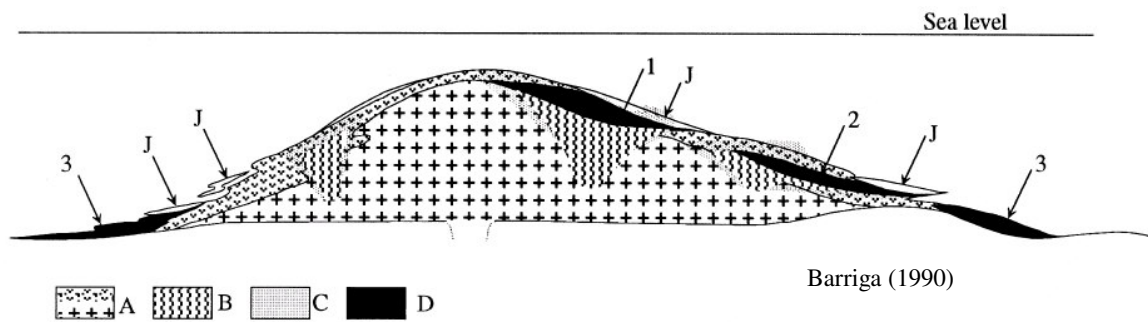
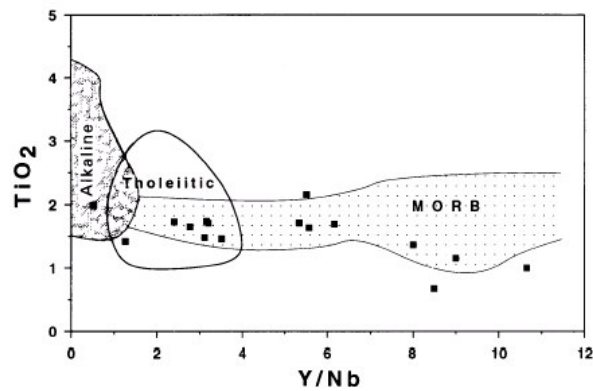


Oxygen isotope geothermometry in IPB mineral deposits indicates that stockworks formed at $\approx 200^{\circ}$ - 270°C (Aljustrel, Rio Tinto, Salgadinho), massive sulphide ores at $\approx 200^{\circ}\text{C}$ (Aljustrel), and hanging wall cherts and jaspers up to $\approx 120^{\circ}\text{C}$ (Aljustrel, Lagoas do Paco, Mertola). $\delta^{18}\text{O}$ and δD values calculated for hydrothermal fluids are represented in Fig. 3. $\delta^{18}\text{O}$ varies considerably between 0 and 6 per mil, whereas δD is remarkably constant (-10 to +15 per mil). These data are interpreted as meaning that mineralizing fluids in the IPB were mostly derived from sea water, perhaps with small contributions of fluids derived from other reservoirs (magmatic, metamorphic), although these are not required by the isotope data.





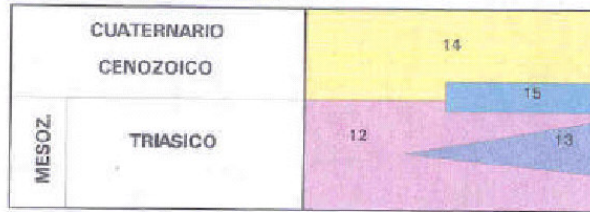
Mitjavila et al. (1997)



Barriga (1990)

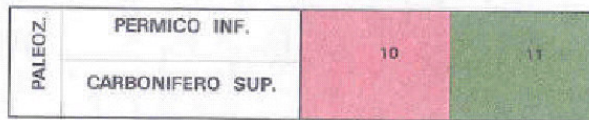
Figure 5. Types of VMS deposits, geologic setting and ore-zone alteration in the IPB (after Carvalho 1979; Barriga 1990). A: Felsic volcanic rocks; B: Predominantly chloritic alteration and cupriferous stockwork; C: Predominantly sericitic alteration; D: Massive polymetallic sulfides; 1: Autochthonous subtype; 2: Transitional subtype; 3: Allochthonous subtype; J: Jaspers with Mn.

COBERTERA POST-PALEOZOICA



- 15.- Gossan
- 14.- Gravas, arenas y arcillas.
- 13.- Basaltos y doleritas
- 12.- Margas y arenas

ROCAS PLUTÓNICAS Y TARDIHERCÍNICAS



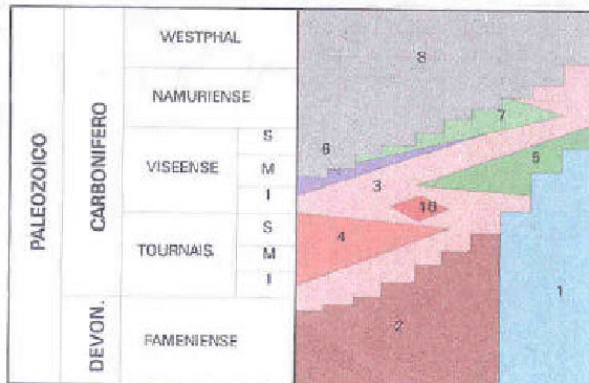
- 11.- Gabros y dioritas
- 10.- Granitos y granodioritas

ZONAS PULO DO LOBO Y OSSA MORENA (Indiferenciadas)



- 9.- Rocas metamórficas indiferenciadas

ZONA SURPORTUGUESA (FAJA PIRÍTICA)



- 8.- Metagrauvacas y pizarras (Grupo Culm)
- 5.- Metavulcanitas básicas
- 7.- Metavulcanitas intermedias y ácidas
- 6.- Pizarras moradas y jaspes (Formación Manganesífera)
- 10.- Sulfuros masivos
- 4.- Metavulcanitas ácidas
- 3.- Metasedimentos y epiclastitas
- 2.- Pizarras, areniscas y cuarcitas (Grupo PQ)
- 1.- Metagrauvacas y pizarras (Bloque Oriental)

CVS

Sulfate assemblages under acidic conditions

Río Tinto average water chemistry (Fernández-Remolar et al., 2004)

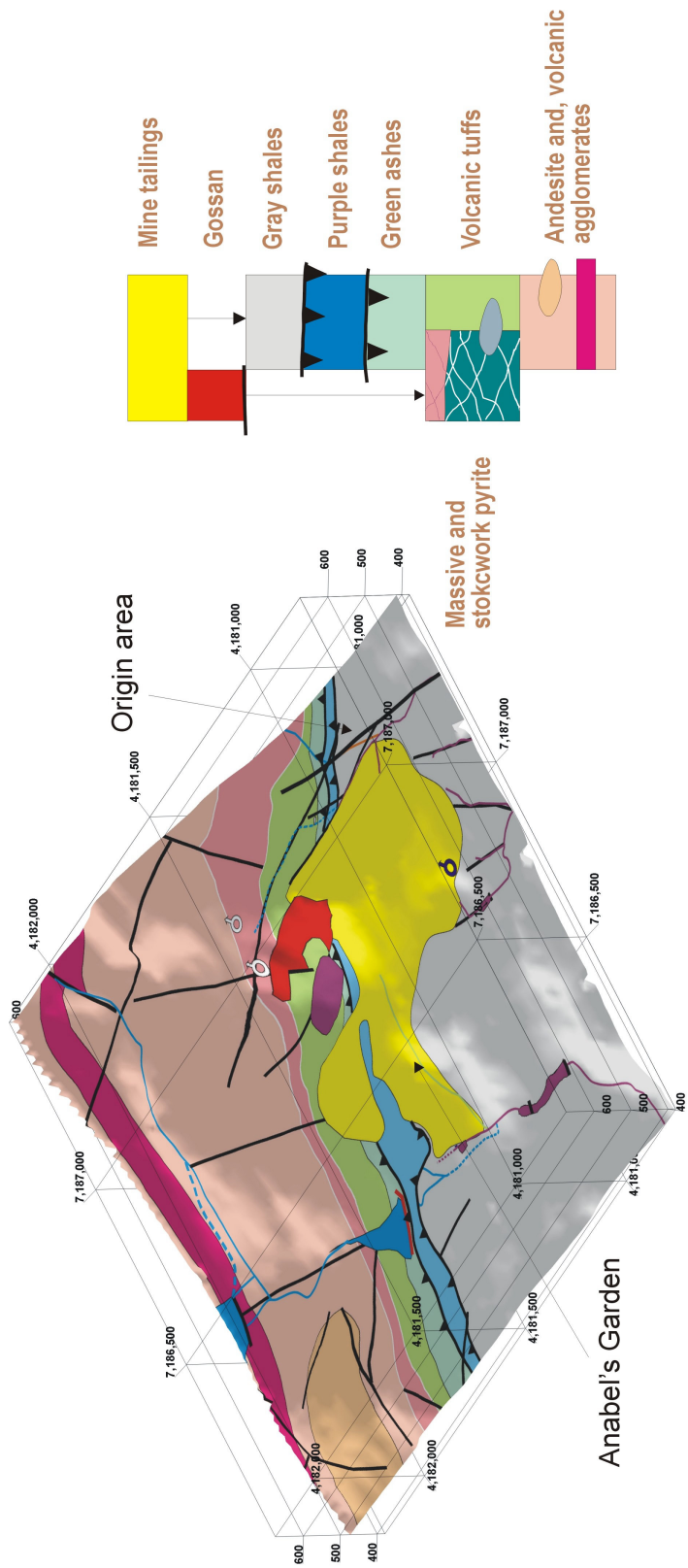
Sample locality	Date											
	07/09/2001						23/02/2001					
	pH	C-mS/cm	Redox-mV	Fe	Si	S	pH	C-mS/cm	Redox-mV	Fe	Si	S
Mine Lake	2.31	3.70	580.00	376.8	9.6	2475.9	2.58	4.29	635	596.298	20.598	502.96
II-Source	1.58	27.57	558.00	20416.0	0.0	66677.5	2.25	24.70	595.90	23118.838	36.030	14266.31
I-Source	2.64	8.87	427.00	707.1	3.6	6819.9	2.83	7.91	368.2	240.542	9.073	598.74
D-Source	1.96	18.73	452.00	243.1	3.6	3646.6	5.2	2.2	132.5	201.399	12.413	303.37
Angeles	1.69	31.77	489.00	17334.1	10.3	64185.9	2.1	32.13	480.8	23853.958	35.514	14988.53
Richi	1.05	25.60	463.00	25928.1	0.0	84366.8	1.98	68.00	458.00	30534.289	27.205	28702.23
Uma	1.35	43.23	478.00	24048.5	14.9	76438.9	2.32	37.5	465	21111.287	36.045	18195.86
Nuria	1.83	13.87	511.00	4760.0	10.4	19120.3	2.53	11.9	538	5061.286	26.740	3202.3
Mine Tunnel	2.52	4.57	560.00	559.7	8.6	3025.7	2.22	16.04	420	840.024	13.110	648.77
Jardin de Anabel	2.67	7.63	421.00	984.1	0.0	5694.5	2.91	5.90	463.67	1153.918	14.572	856.61
La Naya	2.04	19.70	432.00	5196.2	0.0	18318.9	2.30	24.00	370.00	11656.649	21.889	12406.76
Acidic Dam	2.18	8.13	663.00	1985.2	16.8	10328.0	2.99	4.67	500.67	1233.219	13.963	878.02

Concentrations in ppm.

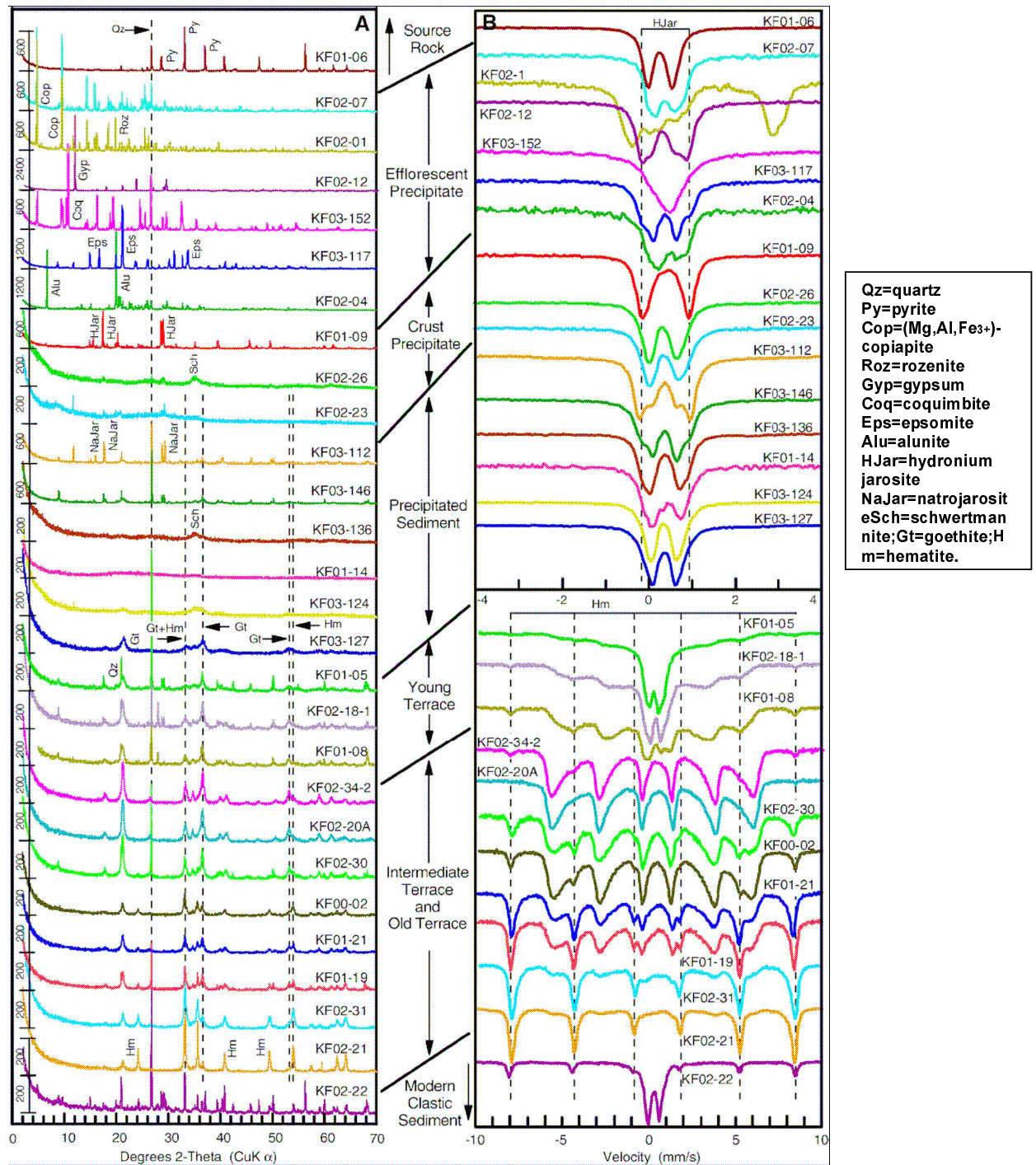
Sample locality	Fe	Mg	Al	Cu	Pb	Si	Zn	Ca	Mn	K	Na	S
Mine Lake	380	150	60	7	0.034	33	28	41	15	0.69	7	700
II-Source	18000	1900	3100	19	0.032	70	21	n.d.	45	n.d.	n.d.	24000
I-Source	36000	16000	26000	200	0.068	320	320	120	1800	n.d.	45	110000
D-Source	260	390	41	0.25	0.0051	7	7.9	220	130	1.4	27	1100
CW-I (Carol Point)	1300	810	280	0.9	0.02	48	9.6	180	170	n.d.	70	3100
Angeles	15000	1200	3800	160	0.027	80	190	37	50	n.d.	4.9	23000
Richi	20000	400	3000	130	0.21	47	120	41	21	20	33	31000
Uma	16000	500	2000	90	0.18	80	130	100	33	n.d.	19	21000
Nuria	4600	390	670	52	0.035	57	100	180	50	n.d.	18	6000
Mine Tunnel	440	140	63	6	0.014	31	29	38	13	n.d.	7	800
East Branch	1.8	64	4.4	0.42	0.008	18	0.62	150	10	2.5	33	270
East Branch+Casiano	2700	44	140	38	1.4	64	9.6	9	6	3.7	6	26000

Concentrations in ppm; n.d., not determined.

Geological 3D map of the area showing the origin and the Anabel's Garden localities to be visited



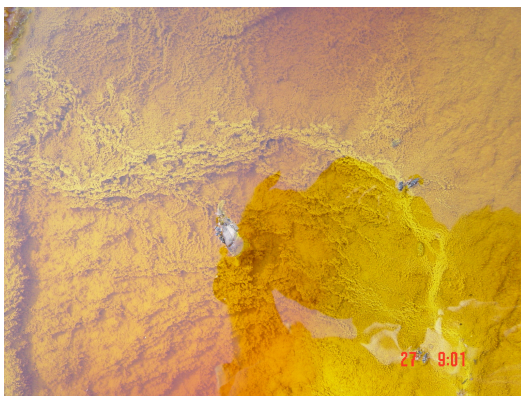
Mineralogy: XRD and Mössbauer spectra of samples from each Río Tinto samples



Origin area: Sourced in three different springs with a pH ranging from 1.5 (Izq-Izq spring), and 2.5 (Izq spring) to 4.5 (Der spring)



Schwertmannite/nanophase iron
oxide coating on microbial structure



Copiapite efflorescences confining
an evaporating pool that produces jarosite

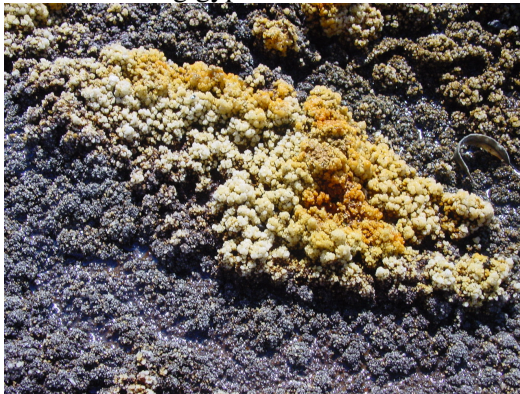


Anabel's garden: sourced in two acidic oxidized and reduced sources producing mainly gypsum efflorescent deposits. Copiapite also can appear as forming yellowish efflorescences. Iron crusts may have schwertmannite and jarosite.

Gypsum blanket in the Anabel's Garden site. Reddish material is microbial.



Detail showing gypsum efflorescences



Copiapite yellowish efflorescences

