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Pasadena Water and Power

Sunset Reservoir Wells Perchlorate Investigation Sources of Perchlorate

Presented by
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Presented to
United States Environmental Protection Agency
at the Jet Propulsion Laboratories, Pasadena
April 30, 2013

Western Electro-Chemical Co.

Pasadena Water and Power

WECCO has been the Sole Manufacturer of Military Grade Ammonium Perchlorate Since 1944

WECCO Has Owned Three Facilities

- Los Angeles CA 1944 – 1946
- BMI Henderson NV 1945 – 1997
- Cedar City UT 1998 - Present

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WECCO History

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1/1944 – Los Angeles 100 tons / month (~3 tons / day)

1/1945 – Los Angeles 200 tons / month (~6 tons /day)

7/1945 – Unit 3 Henderson Nevada 1,200 tons / month (~40 tons / day)

Early 1946 – Los Angeles facility was shut down and all production moved to Henderson

1950 – Henderson increased to 50 tons / day

1997 – 76 Million tons / year (PEPCON + Kerr-McGee) 21,000 tons / day

1997 – 90% of all perchlorate produced in the US was ammonium perchlorate and 90% of the free world's AP was produced in Henderson.

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Perchlorate Production by WECCO

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Year	Los Angeles	Henderson
1944	1,200	0
1945	2,400	7,200
1946	600	14,400
1947	0	14,400
1948	0	14,400
1949	0	14,400
1950	0	17,280
1951	0	17,280
1952	0	17,280
1953	0	17,280
1954	0	17,280
1955	0	17,280
1956	0	17,280
1957	0	17,280
1958	0	17,280
1959	0	17,280
1960	0	17,280
Sub-Total	4,200	254,880
Total	259,080	
Percent	2%	98%

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Stable Isotope Analysis ClO_4 - 1

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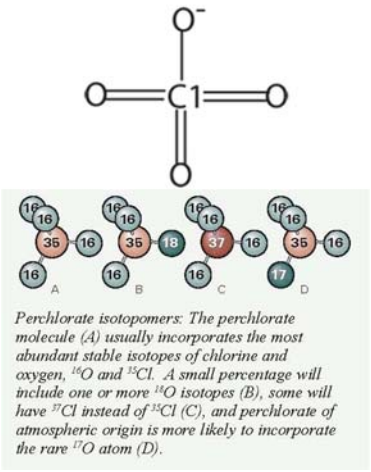
$^{16}O = 16$
$^{17}O = 17$
$^{18}O = 18$
$^{35}Cl = 35$
$^{37}Cl = 37$
$^{35}Cl^{16}O_4 = 99$
$^{37}Cl^{16}O_4 = 101$
$^{37}Cl\,^{17}O_4 = 105$
$^{35}Cl\,^{18}O_4 = 107$
$^{37}Cl^{18}O_4 = 109$



Perchlorate isotopomers: The perchlorate molecule (A) usually incorporates the most abundant stable isotopes of chlorine and oxygen, ^{16}O and ^{35}Cl. A small percentage will include one or more ^{18}O isotopes (B), some will have ^{37}Cl instead of ^{35}Cl (C), and perchlorate of atmospheric origin is more likely to incorporate the rare ^{17}O atom (D).

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Stable Isotope Analysis ClO_4- 2

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1. The Oceans of the Earth have a mean ratio of ^{16}O to ^{18}O of 49,000:1
2. Deviation from this mean is $\delta^{18}O$
3. The Oceans of the Earth have a ratio of ^{16}O to ^{17}O of 263,000:1
4. Deviation from this mean is $\Delta^{17}O$

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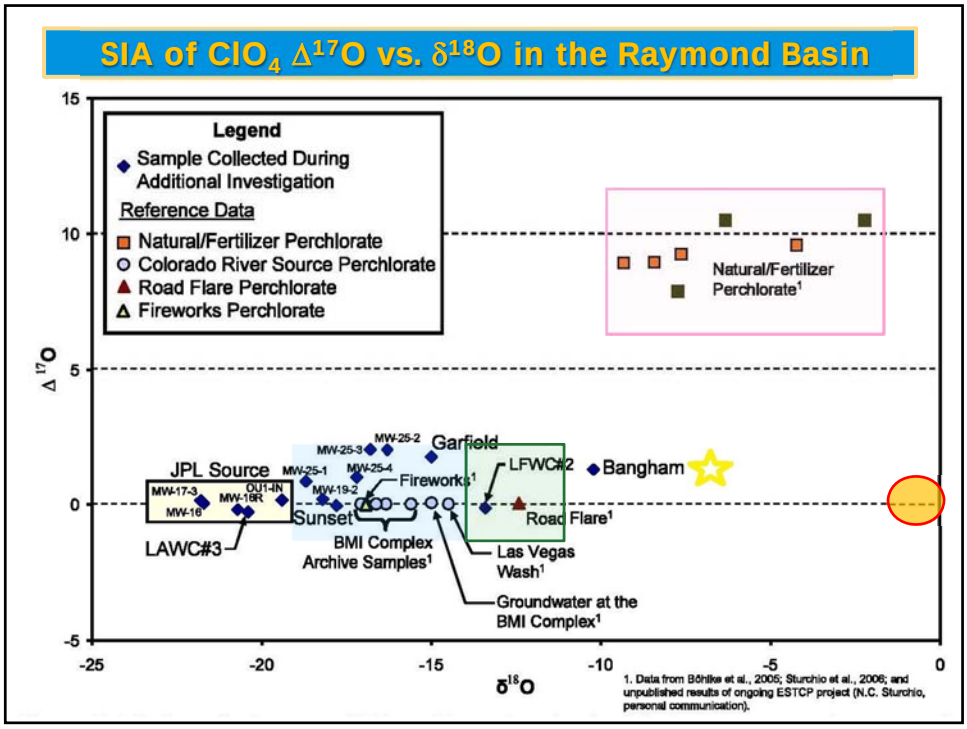
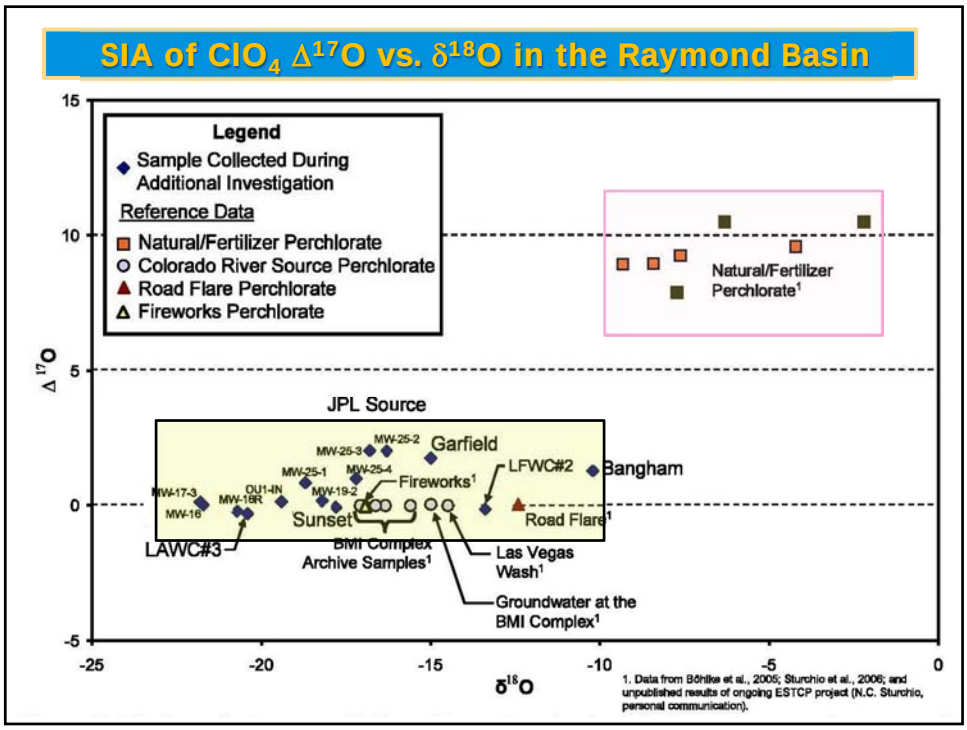

SIA of ClO4 Δ17O vs. δ18O in the Raymond Basin
Legend
Sample Collected During Additional Investigation
Reference Data
Natural/Fertilizer Perchlorate
Colorado River Source Perchlorate
Road Flare Perchlorate
Fireworks Perchlorate
Natural/Fertilizer Perchlorate1
JPL Source
MW-17-3
MW-16
OU1-IN
MW-16R
MW-25-1
MW-25-3
MW-25-2
MW-25-4
MW-19-2
Garfield
Fireworks1
LFWC#2
Bangham
Sunset
Road Flare1
LAWC#3
BMI Complex Archive Samples1
Las Vegas Wash1
Groundwater at the BMI Complex1
Δ 17O
δ18O
15
10
5
0
-5
-25
-20
-15
-10
-5
0
1. Data from Böhlke et al., 2005; Sturchio et al., 2006; and unpublished results of ongoing ESTCP project (N.C. Sturchio, personal communication).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JPL Source
MW-17-3
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OU1-IN
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MW-25-3
MW-25-2
MW-25-4
MW-19-2
Garfield
Fireworks1
LFWC#2
Bangham
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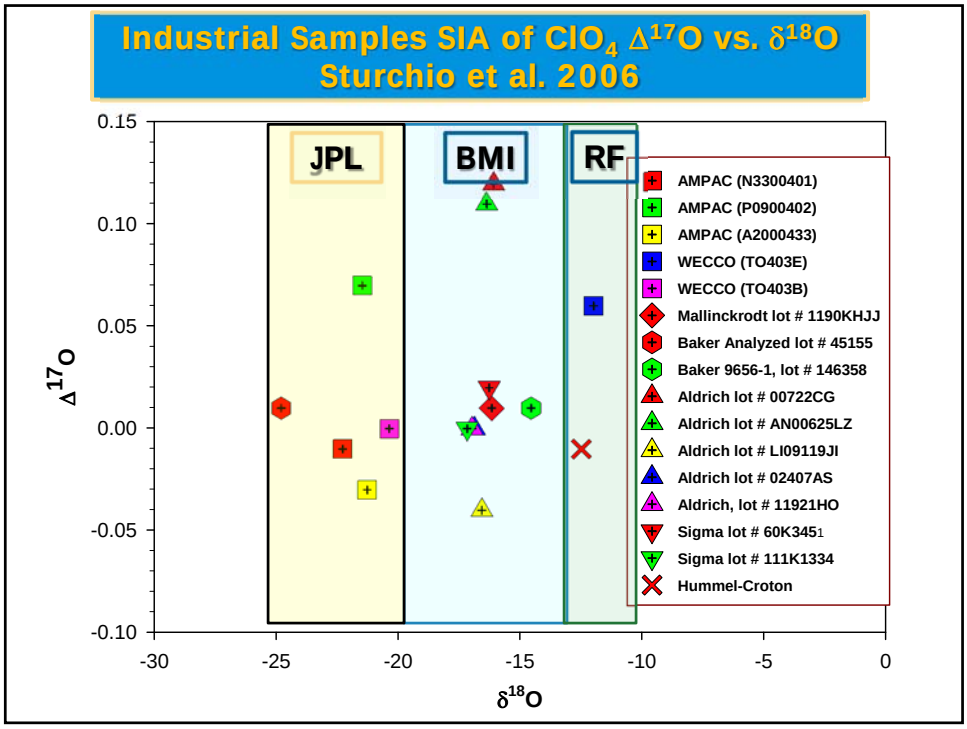
Road Flare1
LAWC#3
BMI Complex Archive Samples1
Las Vegas Wash1
Groundwater at the BMI Complex1
Δ 17O
δ18O
15
10
5
0
-5
-25
-20
-15
-10
-5
0
1. Data from Böhlke et al., 2005; Sturchio et al., 2006; and unpublished results of ongoing ESTCP project (N.C. Sturchio, personal communication).


Industrial Samples SIA of ClO4 Δ17O vs. δ18O
Sturchio et al. 2006
JPL
BMI
RF
0.15
0.10
0.05
0.00
-0.05
-0.10
Δ17O
-30
-25
-20
-15
-10
-5
0
δ18O
AMPAC (N3300401)
AMPAC (P0900402)
AMPAC (A2000433)
WECCO (TO403E)
WECCO (TO403B)
Mallinckrodt lot # 1190KHJJ
Baker Analyzed lot # 45155
Baker 9656-1, lot # 146358
Aldrich lot # 00722CG
Aldrich lot # AN00625LZ
Aldrich lot # LI09119JI
Aldrich lot # 02407AS
Aldrich, lot # 11921HO
Sigma lot # 60K3451
Sigma lot # 111K1334
Hummel-Croton