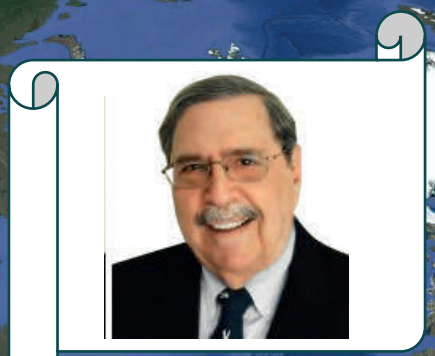
Project History

- 1974 – While at Rice University, Proposed A Comprehensive Uranium - Hydrogeological Exploration Program to U.S. ERDA (now DOE), Grand Junction, Co. (Campbell & Biddle, 1977, p. 17).

- 1977 - Exploration Based on New ERDA National Uranium Resource Evaluation Program (NURE) Reports/Data Released.
- Major Geochemical Anomalies Identified (U, Th & REE))
- URI Raised Funds: $300,000: Recon, Sampling & Analysis, Mapping & Claim Staking: Field Seasons (1977 & 1978)
- URI Final Report Issued in early 1979 Recommending Further Exploration, i.e., drilling and geophysics.
- 1979: Three-Mile Island Nuclear Power Plant Incident. Media fear-pandering overtook U.S. (more).
- Uranium Price Fell & U.S. Nuclear Power Plant Permitting & Construction Ceased, until recently.
- Continued Research & Monitoring over the years, Campbell, et al., (2020a) and 2020b)



Michael D. Campbell, P.G., P.H., CPG

Area of Interest

A *YouTube* version of this presentation is also available (here)

A New Meteor Crater, Old Uranium, Thorium & REE Mineralization, & A New Roll-Front Uranium District … All in Eastern Seward Peninsula, Alaska?

Abstract

International Conference for Applied Geoscience & Energy (IMAGE), Denver, Colorado
September 26 - October 1, 2021

Investigators:

Original Field Team:

Michael D. Campbell, P.G., P.H.

Kevin T. Biddle, Ph.D.

Charles C. Wielchowsky, Ph.D.

Chuck Weisenberg, Ph.D.

Eric Nelson, Ph.D.

M. David Campbell, P.G.

Recent Support:

Robert T. Gregory, P.G.

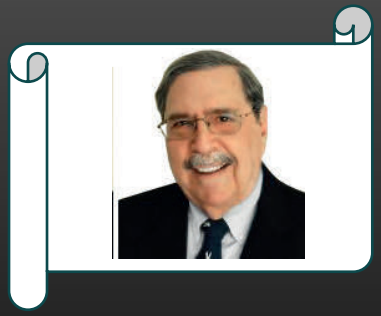
Roger W. Lee, Ph.D.

James L. Conca, Ph.D.

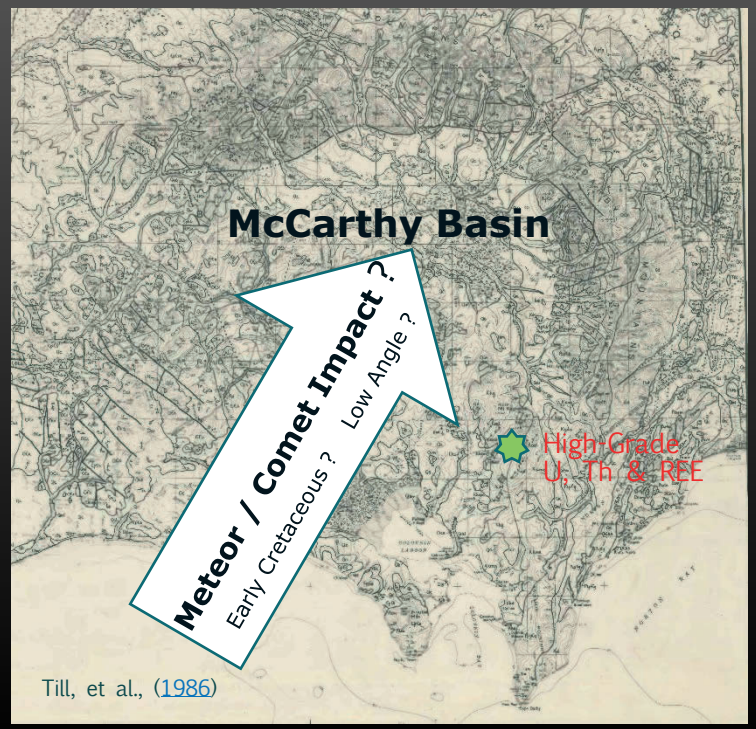
Early Project Results:

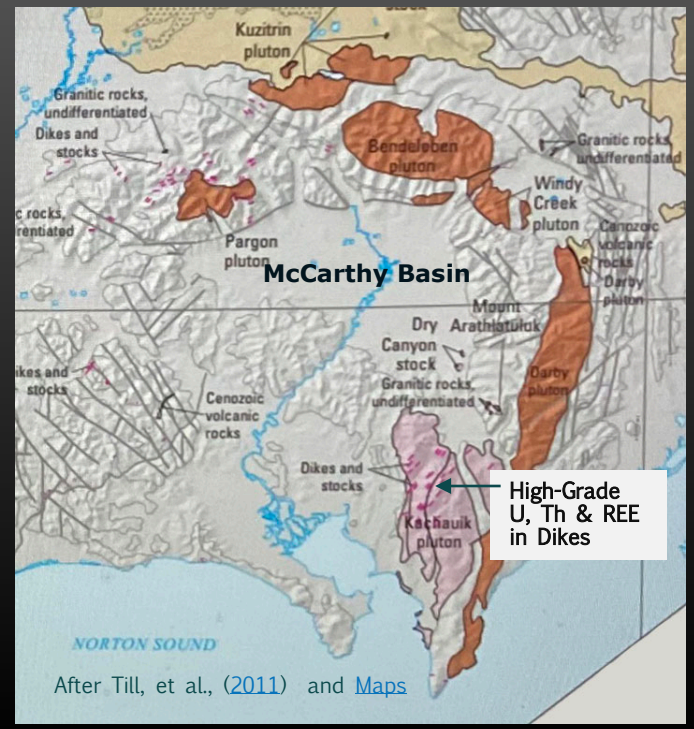
- **High Grade U, Th & REE in Dikes within Cretaceous Kachauik Pluton**
- **Potential Uranium Source: Eastern Edge of Tertiary McCarthy Basin (Crater?)**
- **New U Roll-Front District?**

Project Location

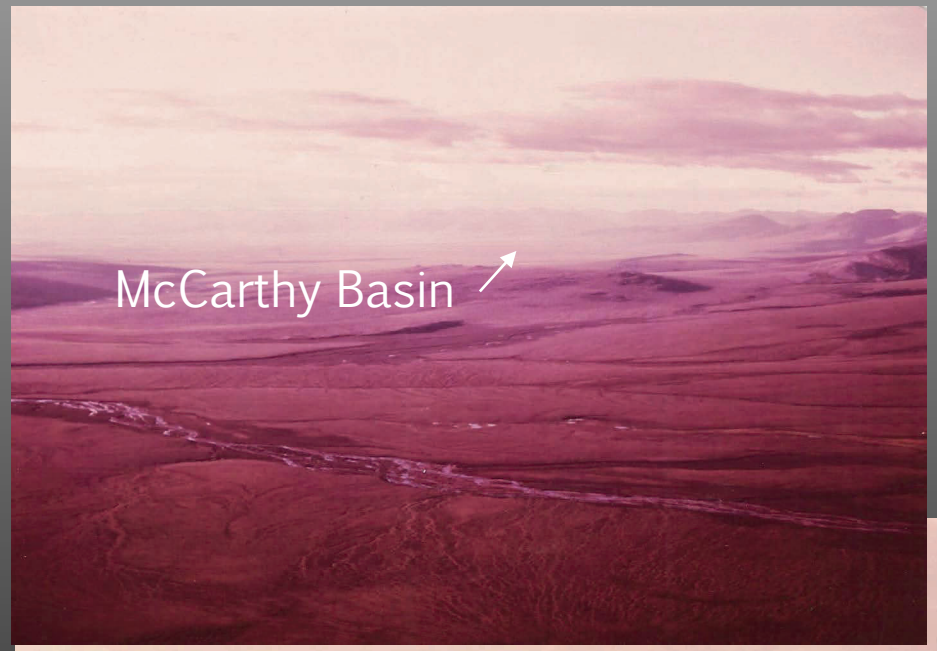


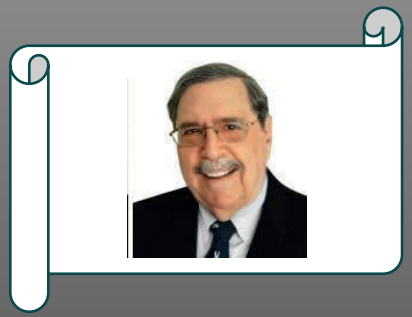
- Identification of McCarthy Basin
- Possible Impact Crater ? TBD
- USGS Indicated 16,000 feet paludal & fluvial sediments of quartz, feldspar, etc. in basin.
- Presence of Lignite
- Analogy present: HOM U discovery in heavily faulted Tertiary sediments with abundant lignite.
- Leaching of U from source to groundwater creating classical roll-front uranium deposit within the eastern section of basin.
- (See Campbell & Biddle, 1977).





In the Field





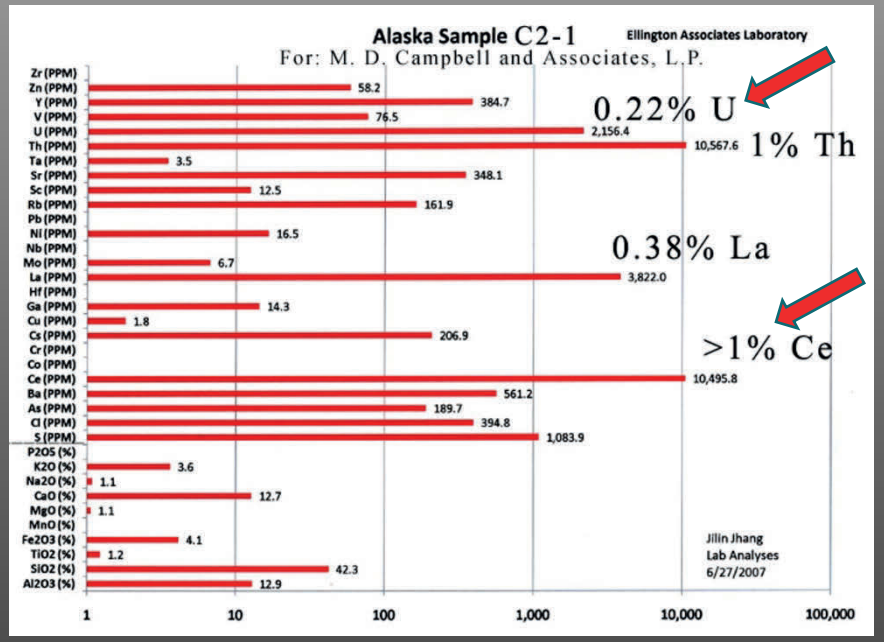
Field Personnel

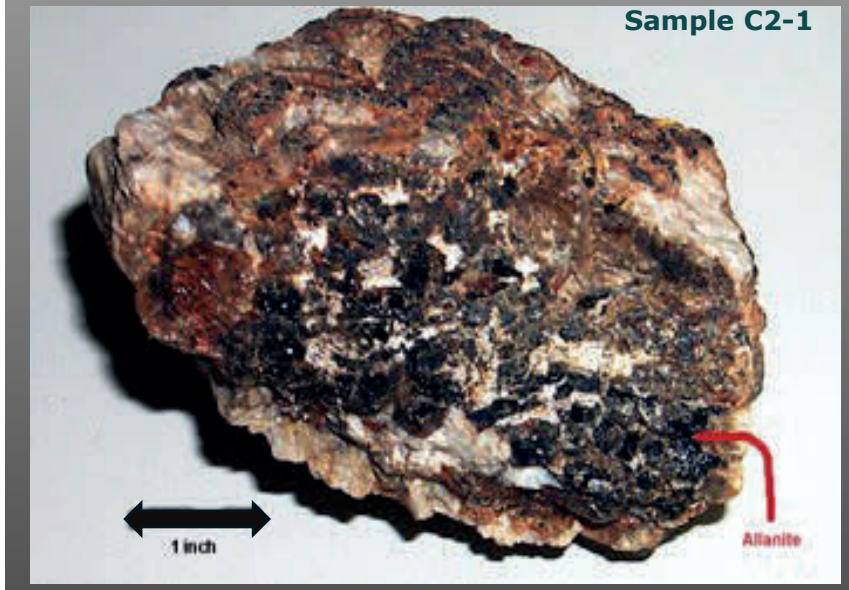
1977 URI* Field Team: Reconnaissance

1978 URI Field Team: Claim Staking, Mapping & Sampling

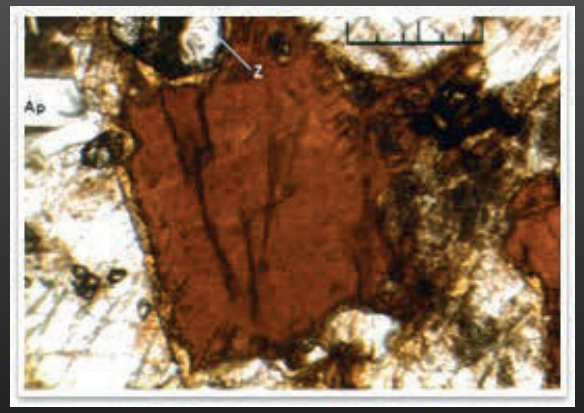
*URI = United Resources International, Houston, Texas (Now I2M Consulting, LLC, Katy, Texas)

Rock-Sample Analyses



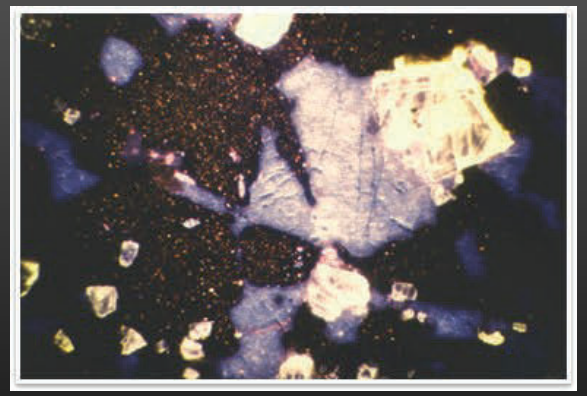


Fresh Break of Outcrop Sample showing large Allanite crystals (Black) within matrix of Feldspar (White)



Allanite in Thin-Section:

- ✓ Allanite with Ce-Ti Reaction Rims (Late Stage = Hydrothermal Activity?)
- ✓ Stress Cracks in Allanite (Brown)
- ✓ Isolated Zircon, Monazite, & Apatite
- ✓ Feldspar (White)



Catholuminescence View:

- ✓ Allanite (Black) w/ numerous nucleation sites for U, Th, & REE
- ✓ Allanite invading Feldspar (Late Stage)
- ✓ All Monazite, Apatite & Zircon Fluorescing ((faint yellow)

Weathered Dike and Igneous Rocks from Outcrop

Rock-Sample Geochemistry

TABLE 5
WHOLE ROCK ANALYSES
(TOTAL MAJOR, MINOR & TRACE ELEMENT SCAN)
(ppm)

SAMPLE LOC.	SAMPLE #	ROCK NAME	U+	Th+	Bi	Tl	Hg	Au	Pt	Ir	Os	Re	W	Ta	Hf	Lu	Yb	Tm	Er	Ho	Dy	Tb	Gd	Eu	Sm	Nd+
Southern Area																										
C2-1	C2-1**	Allanite Monzonite	MC	MC	26	0.8	NR	NR	NR	NR	≤0.1	≤0.8	0.7	≤0.2	15	2	14	2	31	37	150	84	220	44	630	840
C2-1	C2-1A**	Allanite Monzonite	MC	MC	15	20	NR	NR	NR	NR	NR	NR	NR	NR	200	2	11	1	18	23	160	21	180	44	400	MC
C2-1	C2-1C**	Allanite Monzonite	MC	MC	16	2	NR	NR	NR	NR	NR	≤1	NR	≤0.2	98	0.5	5	0.7	21	28	140	18	240	24	420	MC
C2-1	C2-3	Nepheline Syenite	24	150	NR	1	NR	NR	NR	NR	NR	NR	NR	≤3	4	0.3	3	0.4	3	4	12	2	8	4	26	77
C2-6	C2-16	Nepheline Phonolite	34	0.7	44	3	NR	NR	NR	NR	NR	NR	0.9	≤0.8	2	NR	NR	NR	NR	0.5	8	0.9	5	0.6	9	27
C2-6	C2-17**	Allanite Monzonite	MC	MC	12	2	NR	NR	NR	NR	NR	≤2	≤0.7	≤0.6	36	0.8	9	1	56	46	730	67	390	88	MC	MC
C2-14	C2-26	Amphibole Phonolite	30	18	5	5	NR	NR	NR	NR	NR	NR	2	≤0.7	4	NR	NR	NR	NR	NR	4	0.7	2	0.4	3	21
C2-14	C2-27	Augite Syenite	30	81	0.4	5	NR	NR	NR	NR	NR	NR	1	≤0.7	4	0.2	2	0.3	1	2	16	2	10	4	321	85
		Central Area																								
C2-15	C2-28	Allanite Monzonite	53	180	NR	2	NR	NR	NR	NR	NR	NR	NR	≤0.7	9	0.4	2	0.3	2	2	4	0.8	5	1	16	21
C2-17	D2-30	Allanite Amphibole Syenite	110	620	0.6	3	NR	NR	NR	NR	NR	NR	NR	≤1	20	0.7	6	1	7	9	25	6	17	5	68	160
D2-44	D2-52	Melanite Phonolite	30	81	0.4	5	NR	NR	NR	NR	NR	NR	≤0.9	≤2	5	0.2	2	0.3	2	6	16	3	10	5	40	94
D2-44	D2-53	Horn. Biotite Granodiorite	3	17	NR	1	NR	NR	NR	NR	NR	NR	NR	≤0.8	NR	0.1	0.5	≤0.1	0.8	1	2	0.4	3	0.5	5	4
D2-48	D2-57	Melanite Phonolite	67	200	0.7	2	NR	NR	NR	NR	NR	NR	≤0.9	≤2	11	0.2	2	0.3	2	2	9	2	22	3	40	94
D2-61	D2-65	Tremolite(?) Phonolite	320	39	0.2	1	NR	NR	NR	NR	NR	NR	0.9	≤0.3	1	0.1	0.9	0.1	0.8	1	4	0.4	3	0.5	8	10
		Northern Area																								
D2-2	D2-8	Nepheline Syenite	15	41	0.2	≤0.5	NR	NR	NR	NR	NR	NR	≤0.9	≤0.4	1	NR	0.6	≤0.1	0.4	0.5	5	0.4	3	0.6	9	11
D2-2	D2-9	Nepheline Phonolite	51	140	2	≤2	NR	NR	NR	NR	NR	NR	≤2	≤3	3	0.4	2	0.4	1	4	16	4	10	4	27	36
D2-3	D2-11A	Granite	12	260	NR	1	NR	NR	NR	NR	NR	NR	NR	≤0.5	1	NR	NR	NR	0.5	0.7	3	0.5	2	0.8	7	15
D2-3A	D2-12	Allanite Nepheline Syenite	98	270	0.5	2	NR	NR	NR	NR	NR	NR	0.6	≤0.5	2	0.1	1	0.2	1	2	5	0.7	6	0.9	13	31

+Element reanalyzed (XRF, etc.). See Table 2 (wt.%). Not included in trace element content summary.
**Considered mineralized.
NR-Not reported.
MC-Major component .....> 1,000 ppm
— Considered anomalous.
═ Considered strongly anomalous.

SAMPLE LOC.	SAMPLE #	ROCK NAME	Pr+	Ce+	La+	Ba+	Cs	I	Te	Sb	Sn	In	Cd	Ag	Pd	Rh	Ru	Mo	Nb	Zr+	Y	Sr+	Rb	Br	Se	As
Southern Area																										
C2-1	C2-1**	Allanite Monzonite	990	MC	MC	360	28	2	NR	1	7	STD	2	NR	NR	NR	NR	0.8	9	220	550	300	66	≤1	9	7
C2-1	C2-1A**	Allanite Monzonite	990	MC	MC	200	12	0.4	1	3	6	STD	62	NR	NR	NR	NR	2	4	MC	500	760	160	≤0.7	23	4
C2-1	C2-1C**	Allanite Monzonite	MC	MC	MC	MC	11	2	0.7	2	8	STD	29	NR	NR	NR	NR	1	5	MC	240	580	200	21	11	2
C2-1	C2-3	Nepheline Syenite	36	230	360	MC	10	7	NR	NR	6	STD	0.9	NR	NR	NR	NR	2	80	810	51	MC	340	6	2	≤0.7
C2-6	C2-16	Nepheline Phonolite	22	250	250	MC	14	2		NR	0.6	STD	0.7	NR	NR	NR	NR	1	50	280	7	MC	180	2	1	5
C2-6	C2-17**	Allanite Monzonite	MC	MC	MC	720	5	7	≤0.2	1	11	STD	9	NR	NR	NR	NR	4	190	MC	500	970	290	≤3	18	3
C2-14	C2-26	Amphibole Phonolite	25	280	490	900	3	7	≤0.4	NR	0.7	STD	0.3	NR	NR	NR	NR	2	98	530	2		160	4	2	4
C2-14	C2-27	Augite Syenite	40	280	200	MC	12	4	NR	NR	7	STD	0.6	NR	NR	NR	NR	9	44	120	62	MC	160	2	2	≤0.8
		Central Area																								
C2-15	C2-28	Allanite Monzonite	10	280	490	MC	7	2	NR	NR	2	STD	1	≤2	NR	NR	NR	2	24	550	28	680	160	2	2	≤0.8
C2-17	D2-30	Allanite Amphibole Syenite	75	840	840	MC	48	7	NR	6	12	STD	2	NR	NR	NR	NR	3	42	MC	24	MC	MC	6	4	5
D2-44	D2-52	Melanite Phonolite	44	490	490	MC	12	4	NR	1	6	STD	1	NR	NR	NR	NR	2	44	550	62	760	410	2	2	4
D2-44	D2-53	Horn. Biotite Granodiorite	5	24	42	MC	6	2	NR	0.3	2	STD	0.1	NR	NR	NR	NR	1	5	12	7	360	200	0.8	1	≤0.4
D2-48	D2-57	Melanite Phonolite	99	490	880	MC	28	2	NR	0.7	NR	STD	0.6	NR	NR	NR	NR	0.9	98	550	62	MC	MC	2	2	4
D2-61	D2-65	Tremolite(?) Phonolite	19	130	94	MC	6	2	NR	NR	2	STD	0.3	NR	NR	NR	NR	0.8	12	6	12	650	70	2	1	13
		Northern Area																								
D2-2	D2-8	Nepheline Syenite	11	56	80	MC	11	2	NR	0.3	0.9	STD	0.2	NR	NR	NR	NR	0.5	12	62	7	390	560	3	1	2
D2-2	D2-9	Nepheline Phonolite	17	190	340	MC	5	4	NR	1	3	STD	1	NR	NR	NR	NR	9	75	210	24	MC	280	7	4	3
D2-3	D2-11A	Granite	7	79	110	MC	9	3	NR	1	1	STD	0.4	NR	NR	NR	NR	2	7	87	4	220	290	1	2	3
D2-3A	D2-12	Allanite Nepheline Syenite	14	160	160	170	4	29	≤0.5	0.5	1	STD	0.1	3	nr	NR	NR	0.7	8	40	16	100	360	1	2	1

+Element reanalyzed (XRF, etc.). See Table 2 (wt. %). Not included in trace element content summary.
**Considered mineralized.
NR-Not reported. STD- Indium as standard.
MC-Major component (~0.1%) —Considered anomalous. ═Considered strongly anomalous.

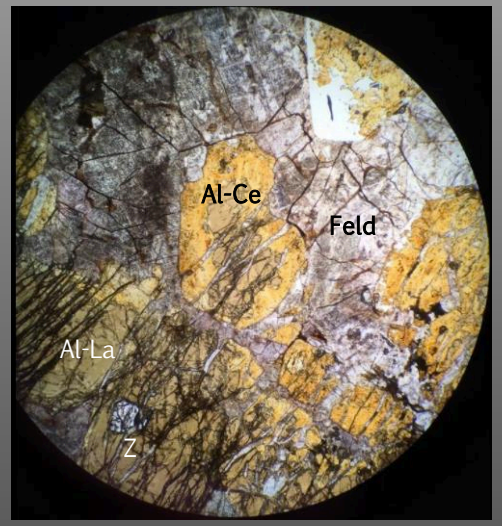
> 1,000 ppm

Whole-Rock Geochemistry

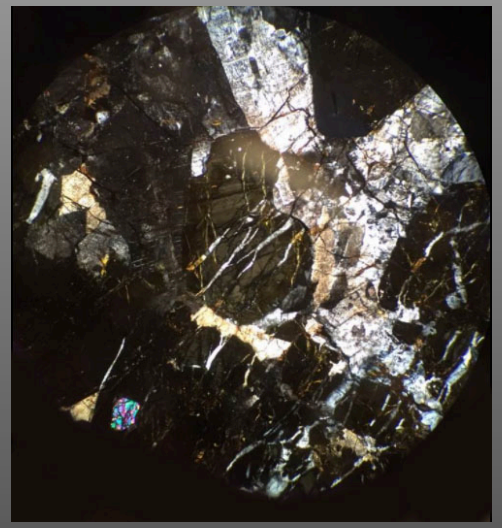
- ✓ 11 Elements > 1,000 ppm (MC)
- ✓ In Allanite Monzonite: U, Th, La, Ce, Sm, Pr, Nd, and
- ✓ In Allanite Amphibole Syenite, Melanite Phonolite and Tremolite Phonolite: Ba, Zr, Sr, and Rb
- ✓ Others “Anomalous”: Eu, Tb, Cs, Sn, Ag, Mo, Nb, Cs, I, Nb, etc.

Campbell, et al., (2018)

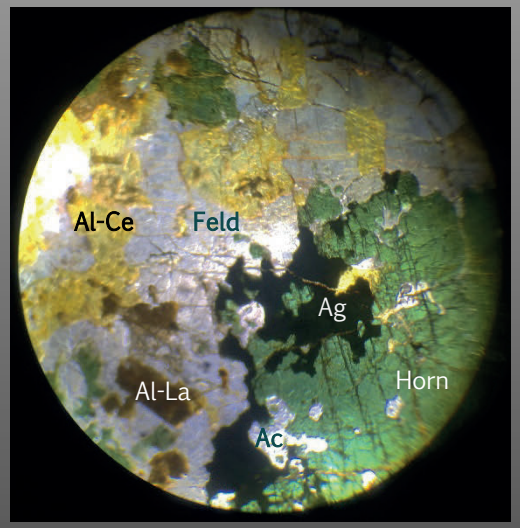
Rock-Sample Microscopy



Samples C2-1 50X Transmitted Light



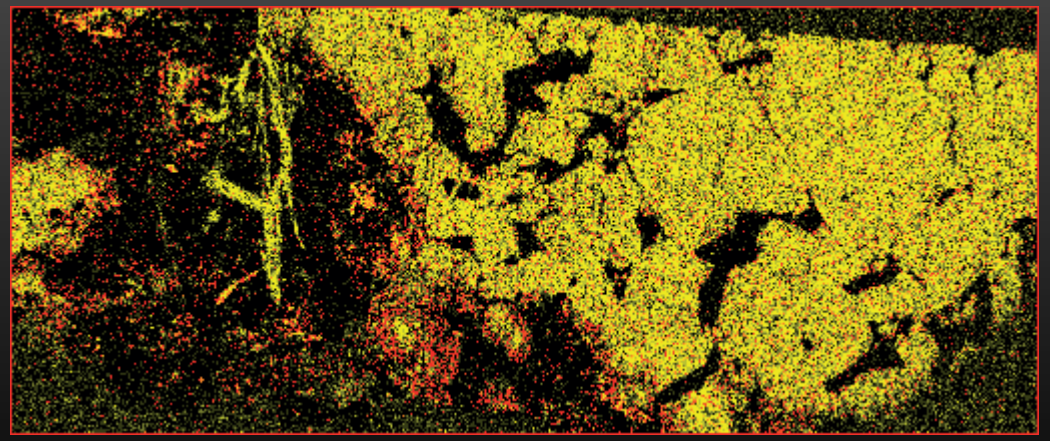
Crossed Nicols View



Sample C-17 50X Transmitted Light

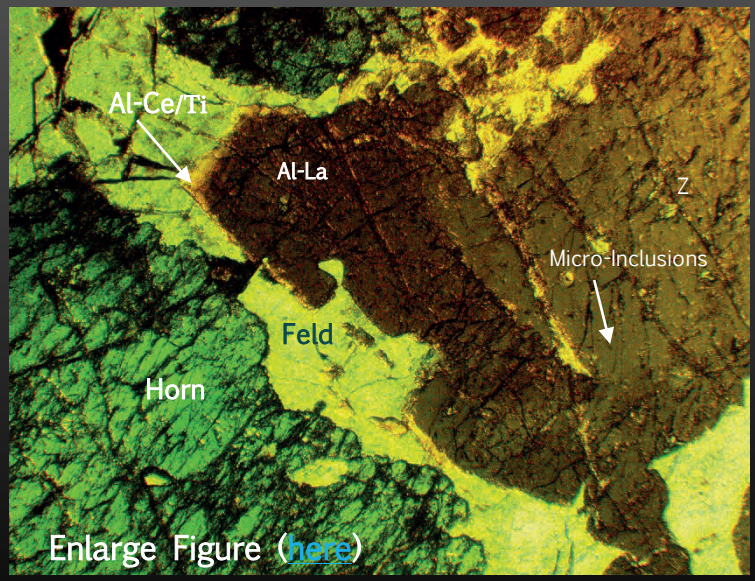
Al-La = La-Allanite Al-Ce = Ce-Allanite Feld = Feldspar Z = Zircon Horn = Hornblende Ag = Augite Ac = Accessory Minerals, (Monazite, Apatite, etc.)

- Indicating Two-Stage (Ce-La) Allanite Formation
- Indicating Stress-Cracks – Facilitating Drainage

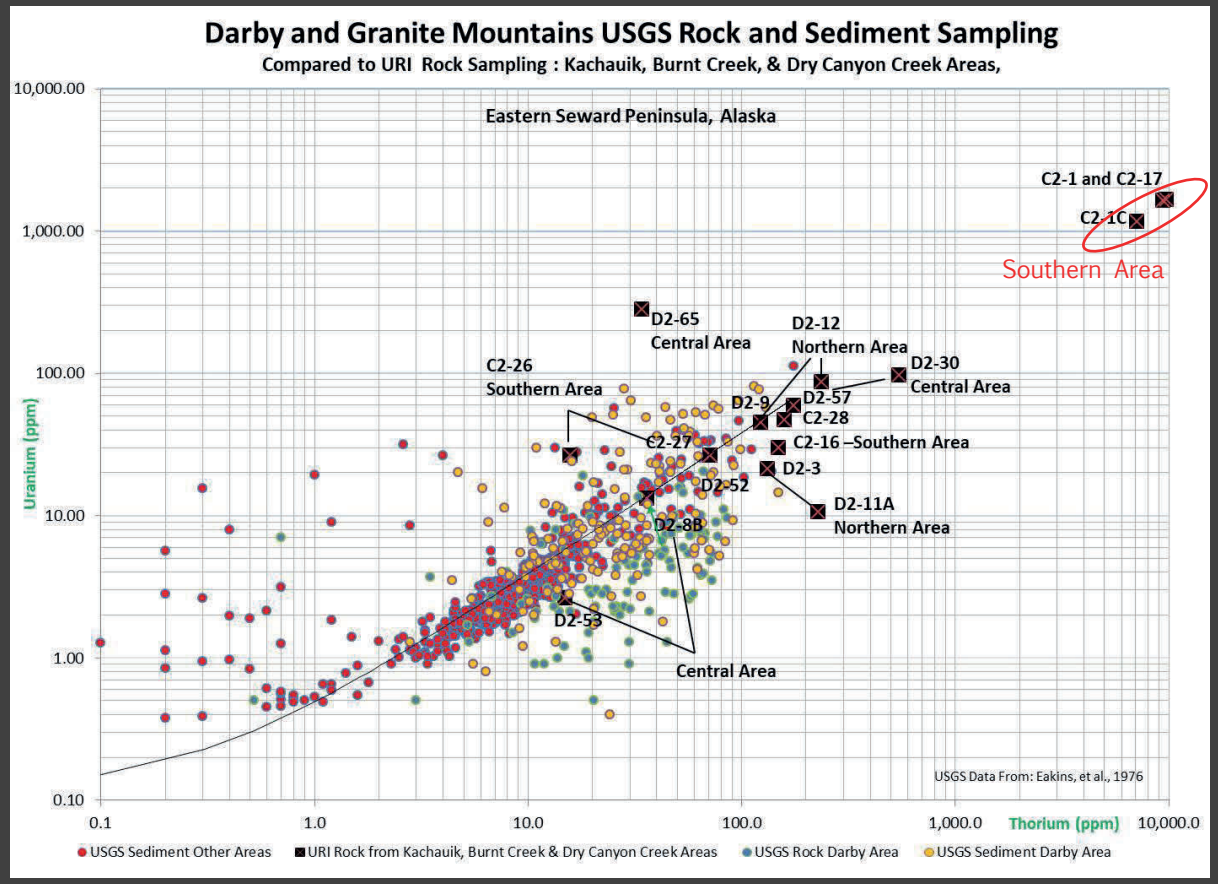


Sample C2-1 XRF- Allanite– Containing Abundant Calcium (Yellow), with Ti (Red) and Ce (Orange) Reaction Rim and Ti in Feldspar (Black)

Campbell, et al., (2018), especially pp. 29-30, and Appendix II, pp. 61-62



Sample C-17 100X Transmitted Light
Note Stress Cracks and Micro-Inclusions in Al-La



Types of Alkaline Rocks Sampled

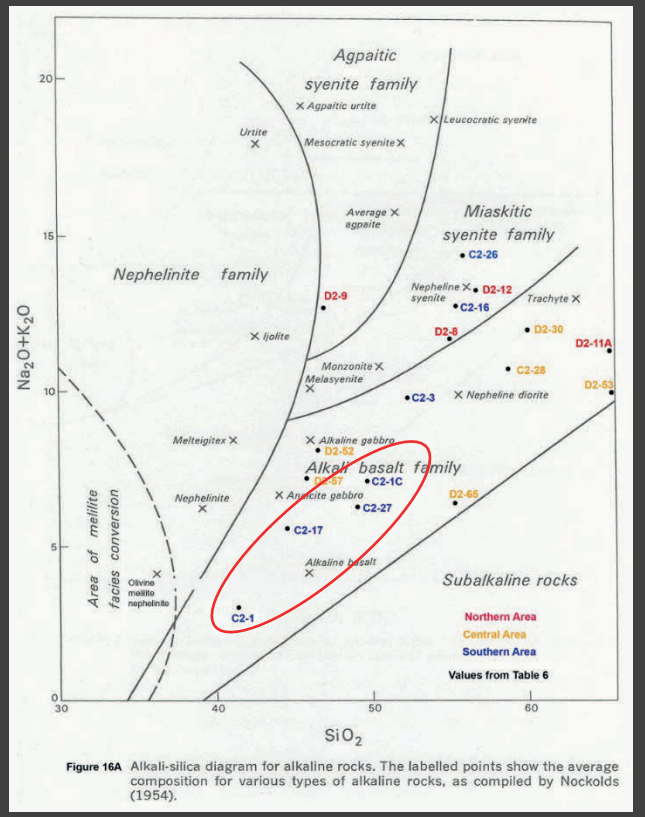


Figure 16A Alkali-silica diagram for alkaline rocks. The labelled points show the average composition for various types of alkaline rocks, as compiled by Nockolds (1954).

Regional Uranium / Thorium Distribution Plot

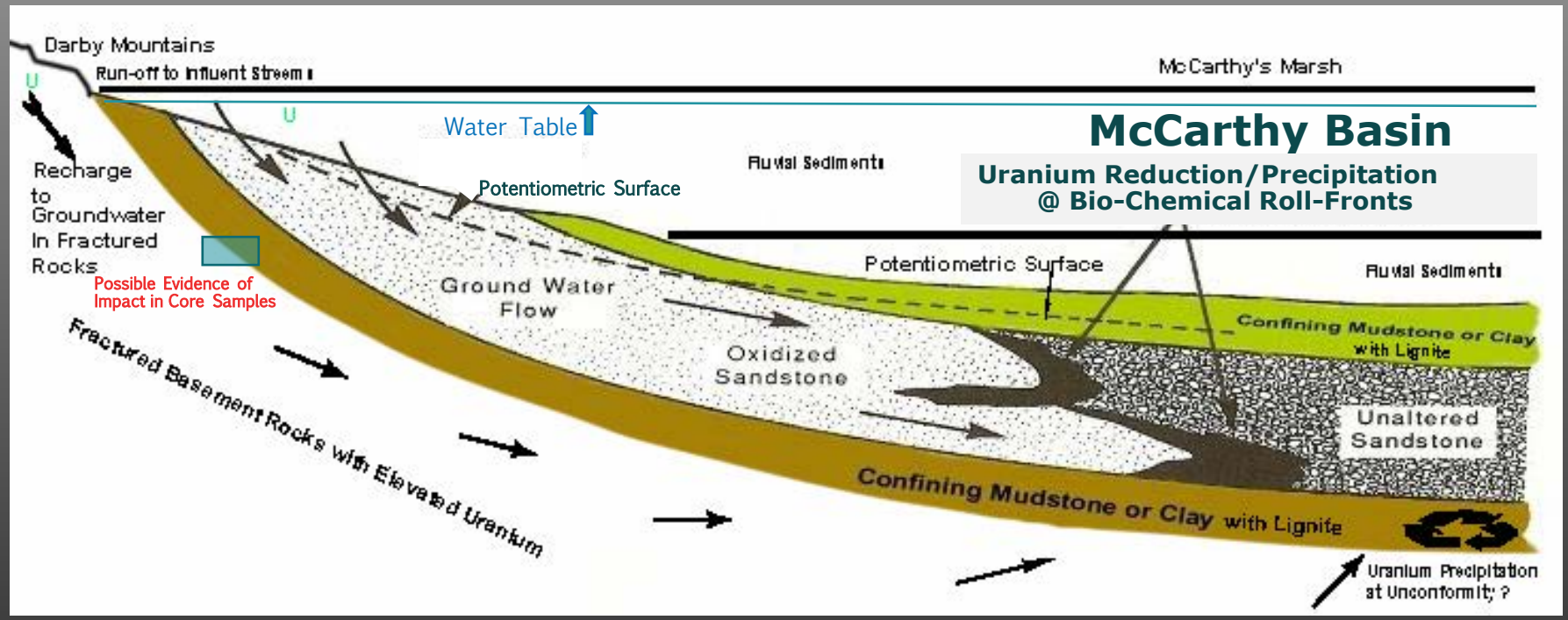
- Plot Shows URI Samples (Rock) in Context with U.S.G.S. Sampling (Rock and Sediment)
- URI Samples (Black boxes) average higher in U/Th
- URI Samples in Mineralized Zone very high in U/Th
- URI Samples from three Plutons:

  Northern Area ..... Dry Canyon Creek Pluton (high U),
  Central Area .... Burnt Creek Pluton (high U), and
  Southern Area .... Kachauik Pluton (with mineralized zones (high U & REE))

SiO_2 vs. Alkalinity Ratio Plot

- Samples from Mineralized Zone with >>> REE Concentrations
- Decreasing SiO_2 + Increasing Alkali .... Carbonatite Nearby ?
- Numerous Types of Subalkaline Rocks in Area.

Assembling Evidence: Generalized Model of Likely Uranium Roll-Front Development in McCarthy Basin



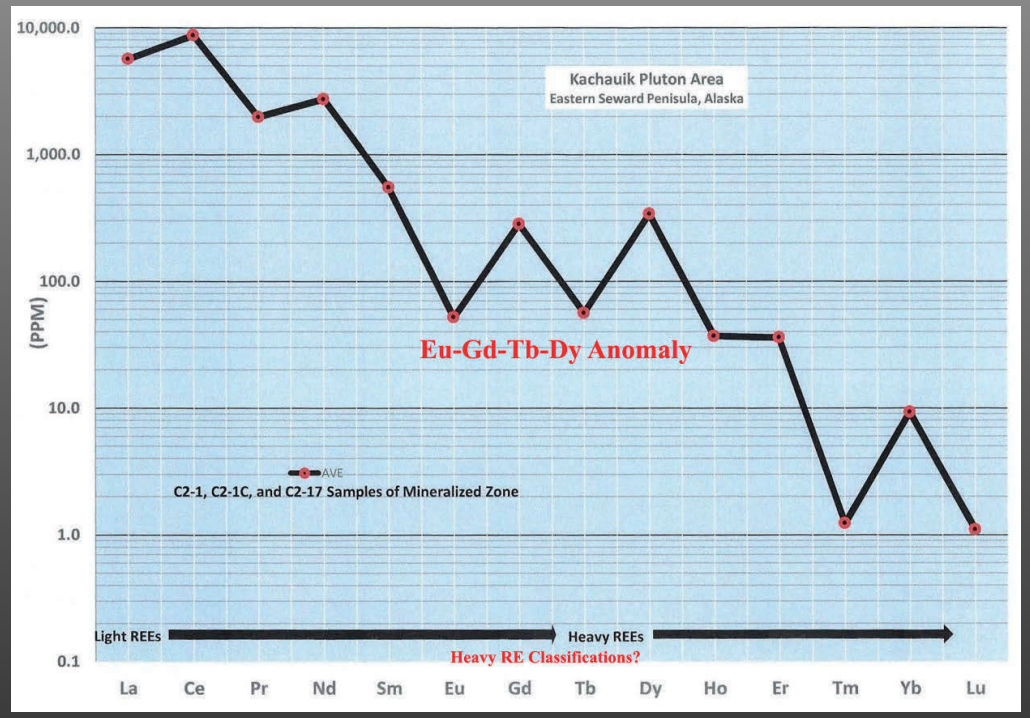
Basic Requirements are Present:

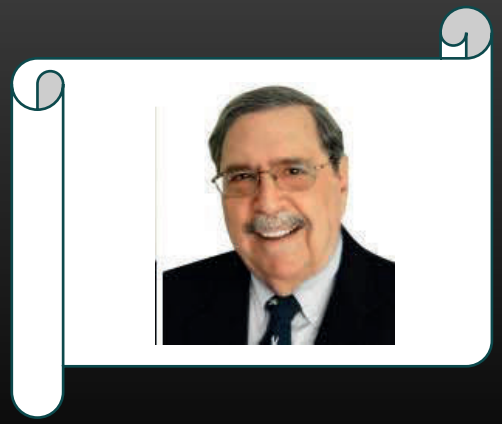
- ✓ Uranium Source Rocks of Cretaceous Age are in Proximity to Basin Containing ~16,000 Ft. of Tertiary Fluvial Sediments w/Lignite.
- ✓ Analogue Present of a Roll-Front Uranium Occurrence in Fault-Blocked Tertiary Sediments South of Death Valley Basin.
- ✓ Groundwater Recharges the Basin with Elevated Uranium… Likely Forming Multiple Uranium Roll Fronts @ Shallow Depths.

Question: Where in Basin are Roll Fronts Likely to Occur? **Where Lignite (or H_2S or ?) Provide Reducing Conditions.**

What About the Rare-Earth Mineralization ?

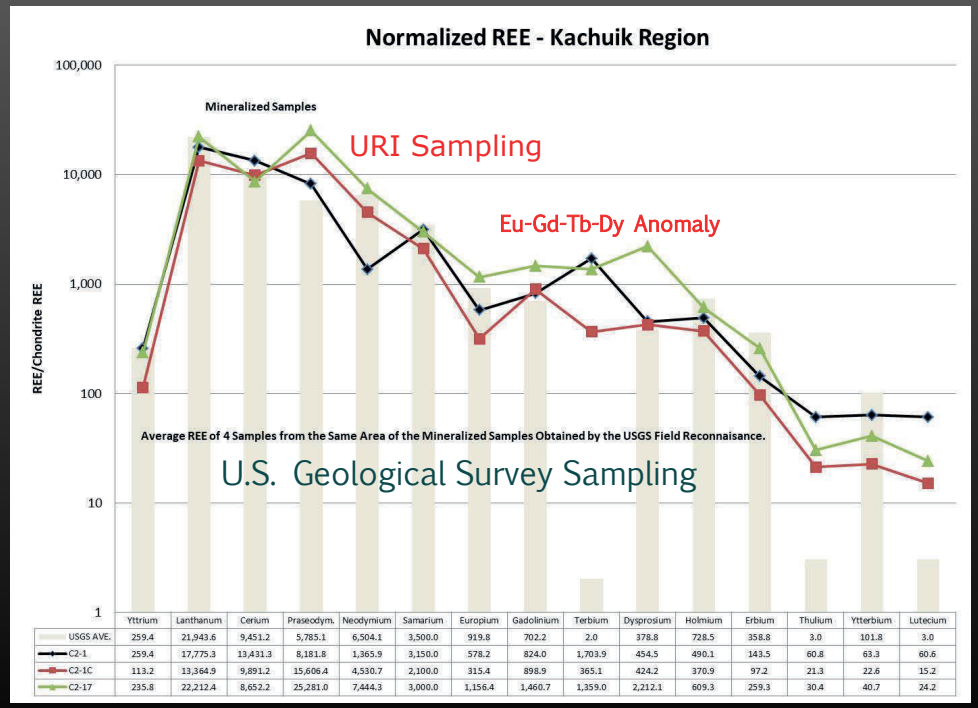
Average REE Concentrations- Kachuik Region – Mineralized Zone





REE Concentration Plots Indicate:

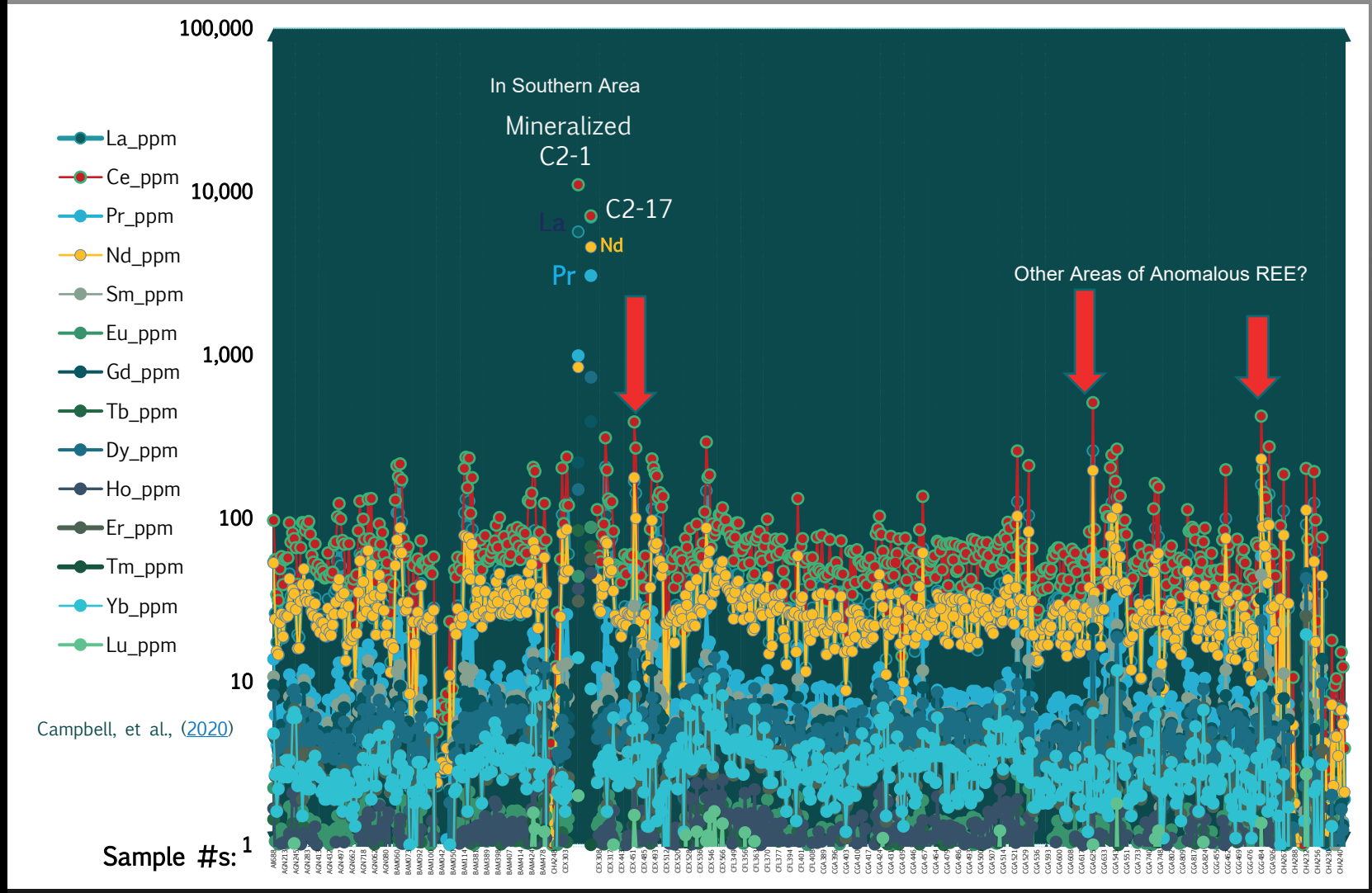
- Averaged Concentration of REE Samples
- A Clear Eu-Gd-Tb-Dy Anomaly
- Normalized REEs Show No Negative Eu Anomaly



	Yttrium	Lanthanum	Cerium	Praseodym.	Neodymium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutecium
USGS AVE.	259.4	21,943.6	9,451.2	5,785.1	6,504.1	3,500.0	919.8	702.2	2.0	378.8	728.5	358.8	3.0	101.8	3.0
C2-1	259.4	17,775.3	13,431.3	8,181.8	1,365.9	3,150.0	578.2	824.0	1,703.9	454.5	490.1	143.5	60.8	63.3	60.6
C2-1C	113.2	13,364.9	9,891.2	15,606.4	4,530.7	2,100.0	315.4	898.9	365.1	424.2	370.9	97.2	21.3	22.6	15.2
C2-17	235.8	22,212.4	8,652.2	25,281.0	7,444.3	3,000.0	1,156.4	1,460.7	1,359.0	2,212.1	609.3	259.3	30.4	40.7	24.2

(Campbell, et al., (2020c)

Distribution of REE in Area

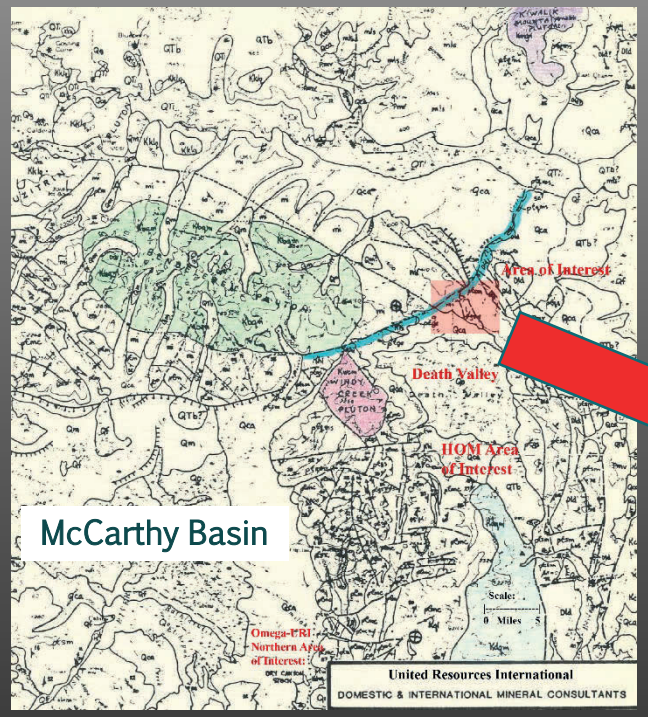


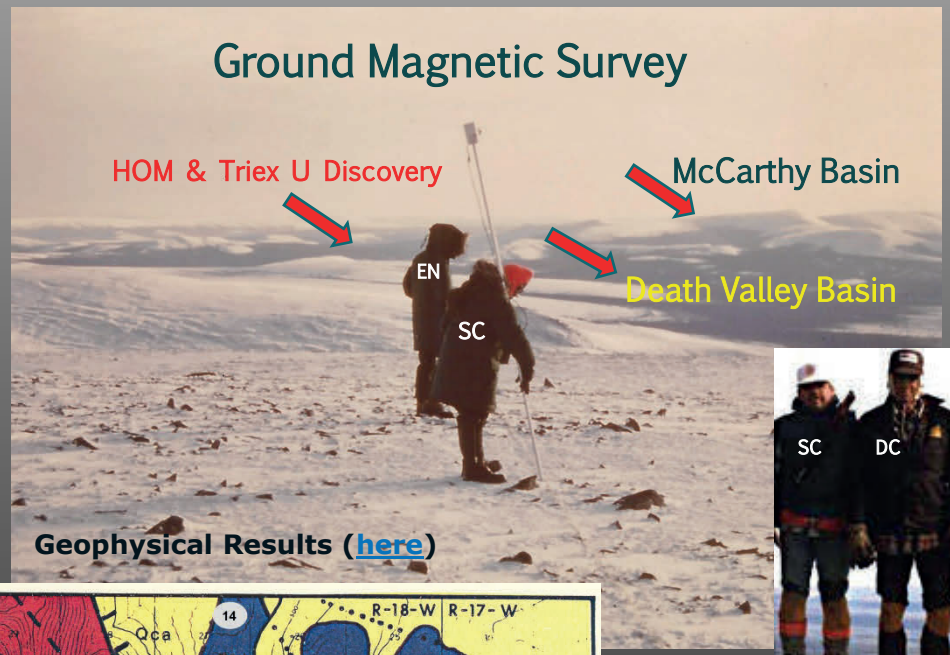
Campbell, et al., (2020)

- Geochemical Survey of **REE** in Area by USGS and consultants in general area of **REE** mineralization, shows anomalies.
- Graphic shows how widespread **REE** are in sediments derived from igneous rocks in 100 sq. mile area around mineralized zones.
- **Ce** dominates **REE** group, with decreasing concentrations of **La**, **Nd**, **Pr**, etc., in mineralized zones.

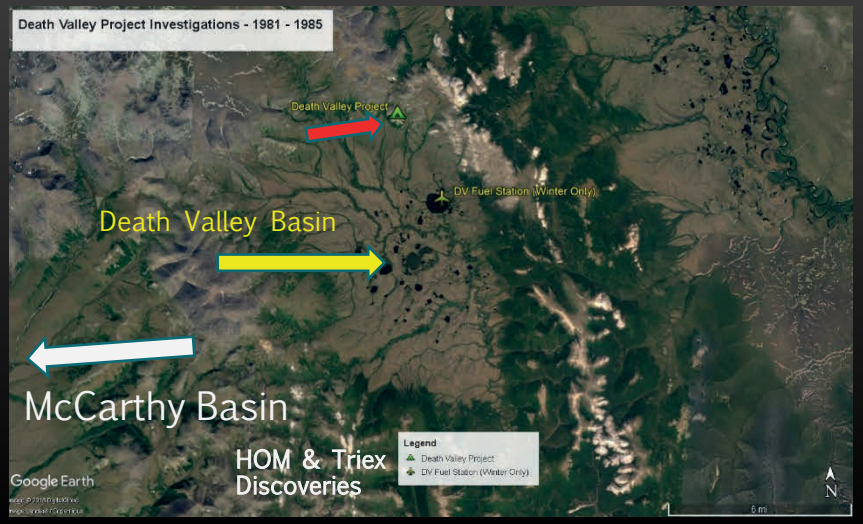
>>>> No Eu Negative Anomaly.

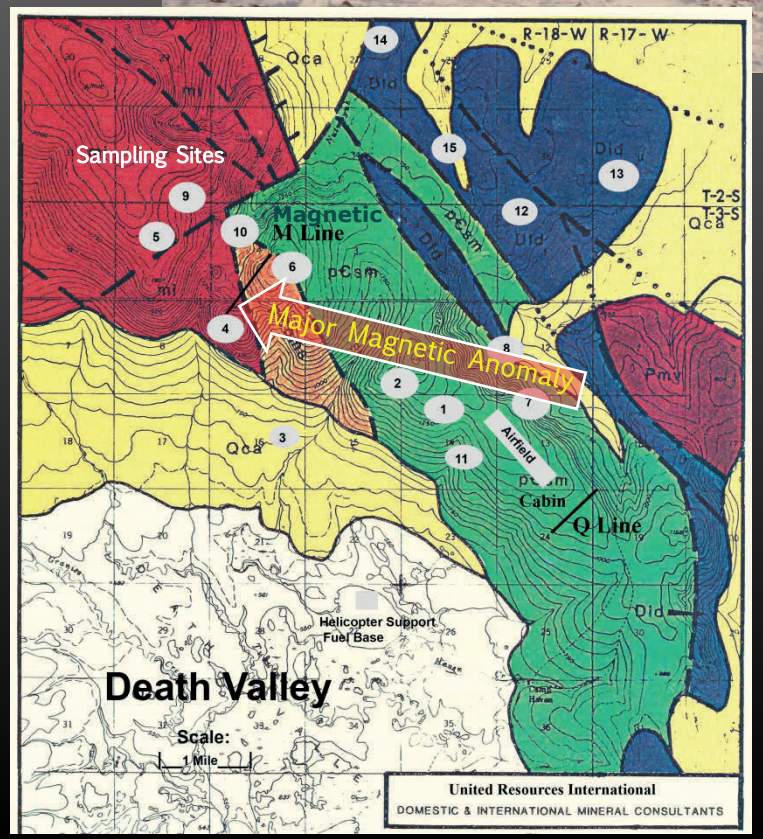
What About Near-By Death Valley Basin ?

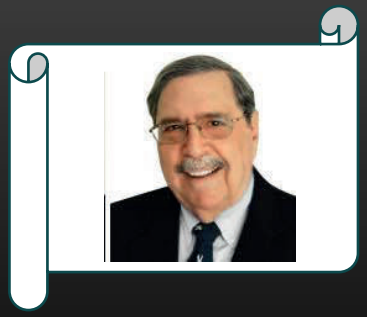




1982 Field Team







For the rest of the story, see Campbell, et al., (2018)

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For additional information available from our research over the years on the subject matter, see below in PDF version from the **I2M Web Portal**:

1. Allanite (here) 2. Uranium in Alaska (here) 3. Rare Earths in Alaska (here)

"I'll be glad to speak to you further on this very interesting project."

"Have a good year."

For PDF with hyperlinks, see:
http://i2massociates.com/downloads/Campbell2021IMAGE.pdf