

FLUORINE **FORUM** 2017

San Luis Potosí, Mexico
30 Oct-2 Nov 2017



Fluorspar to 2018 and beyond

Gerry Clarke & Peter Huxtable

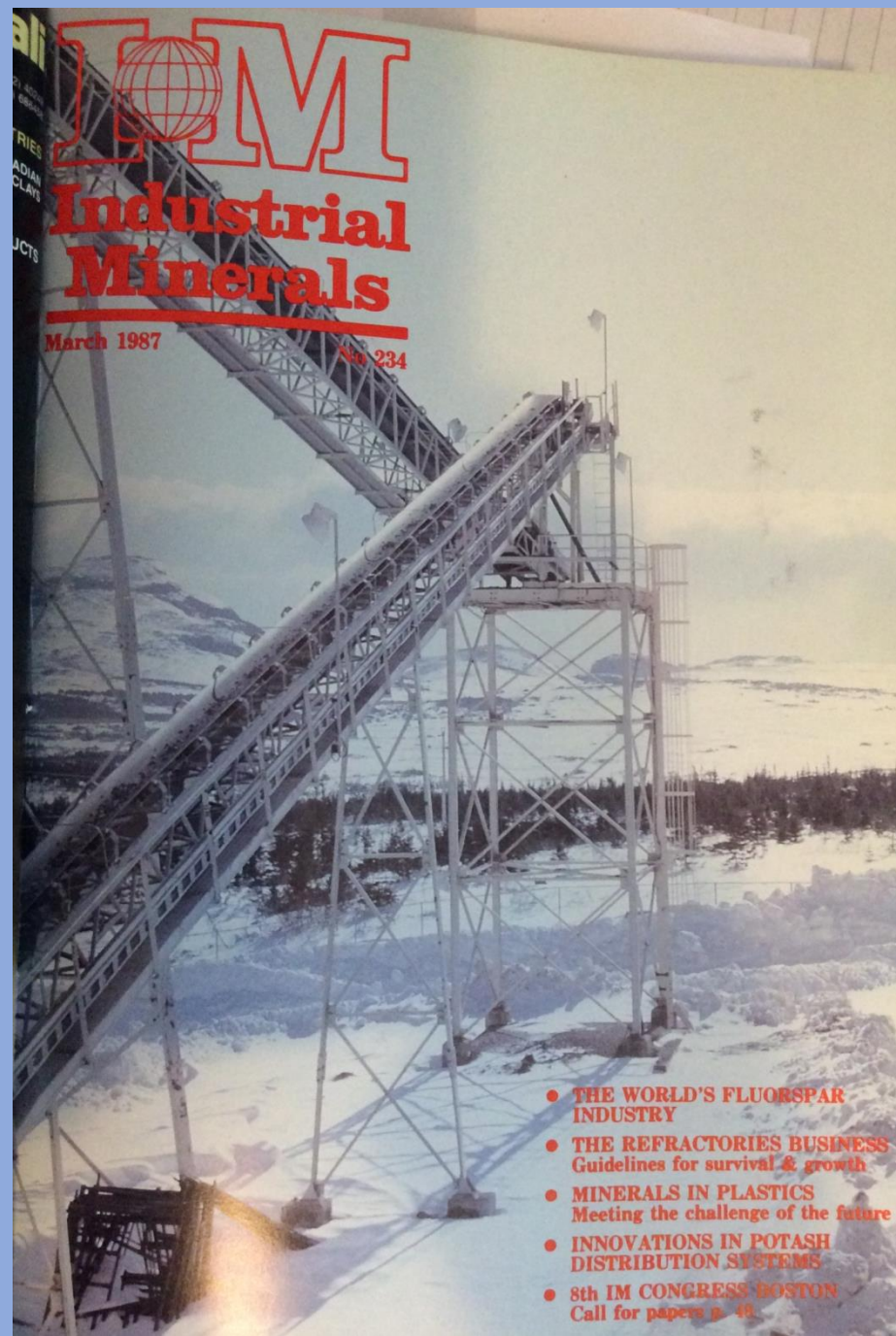
In March 1987 I wrote,

“The world of fluorspar probably has more “experts” following its course than most other minerals. Well this is the gospel according to IM!”

Err, me, as Editor, 30 years ago.

But today I am greatly assisted by Peter Huxtable for which I am equally appreciative.

So what else happened 30 years ago?



IM **Industrial Minerals**

March 1987 No. 234

- **THE WORLD'S FLUORSPAR INDUSTRY**
- **THE REFRACTORIES BUSINESS**
Guidelines for survival & growth
- **MINERALS IN PLASTICS**
Meeting the challenge of the future
- **INNOVATIONS IN POTASH DISTRIBUTION SYSTEMS**
- **8th IM CONGRESS BOSTON**
Call for papers p. 48

How to make sense of it all?

The past is the key to the present

As any traditional geologist will tell you!

&

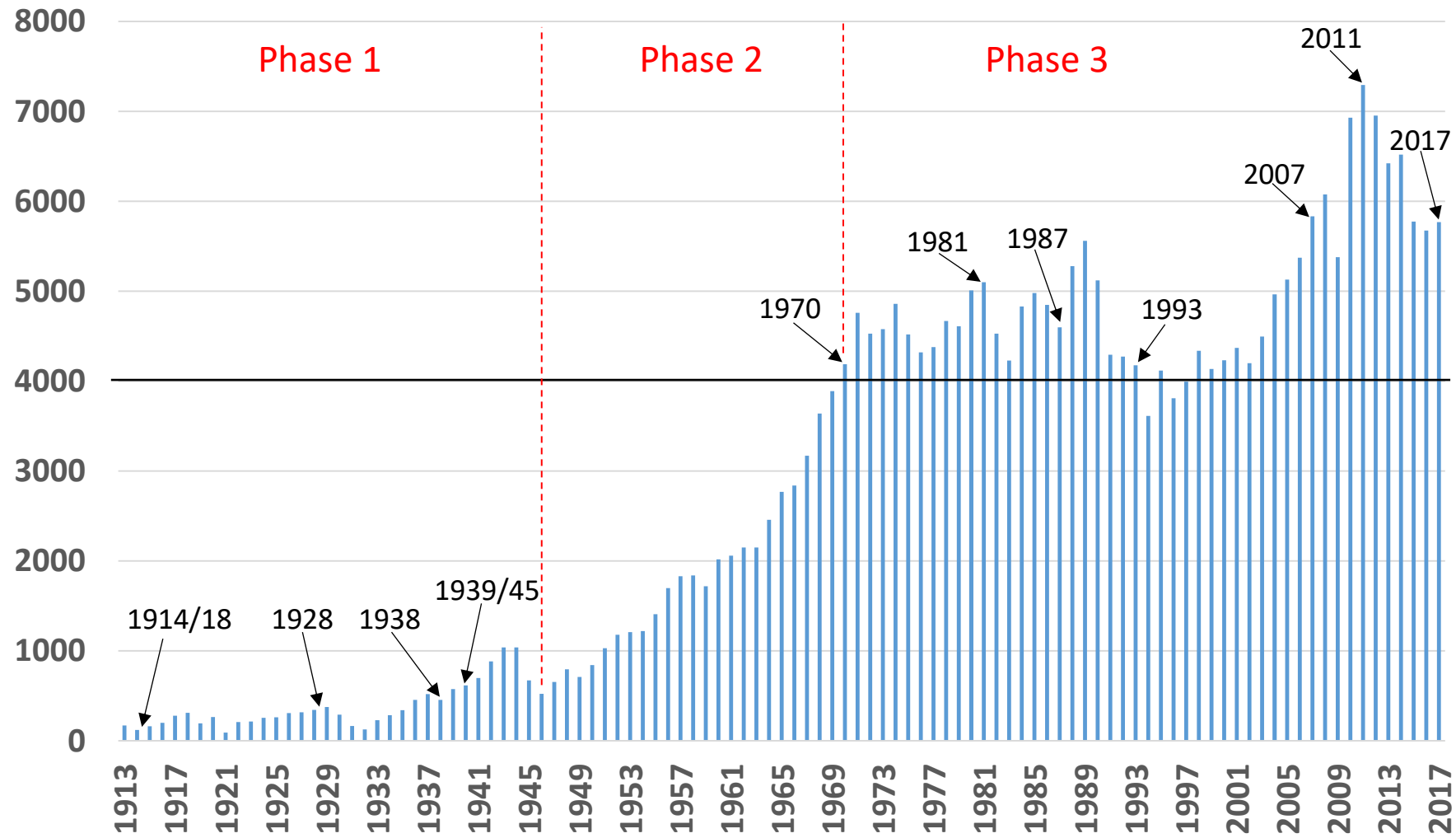
You can't have a vision without knowing how you arrived at the present

So let's take a look.

First, a few basics about F

- 13th most abundant element in Earth's Crust at 540ppm
- Highly reactive and potentially dangerous halogen
- 1520: first noted the mineral (fluorspar) would melt in a fire
- 1886: Henri Moissan isolated F by electrolysis – risky business!
- Fluorine's name derived from “fluere”, to flow: **flux** – first clue!
- Trapped in mineral, fluoride, stable/essential to life: 1945 **F'n USA**
- Fluorspar: Predominant source CaF_2 contains 48.67% F
- Other F Minerals: apatite (1.24-1.50%), cryolite (54.30%), sellaite (60.99), villiaumite (45.25%), synthetic by-products
- 1928: Midgely **FCs** and 1938: Plunkett **PTFE** – heat resistant plastic

World Production of Fluorspar 1913-2017 (kt)



Fluorspar production rollercoaster 1913-2017										104	
							Change			History	
		Year	mt	Year	mt	Yrs	mt	%	% p.a.	%	
1	Rise	1913	0.1	1943	1.0	30	0.9	900	30	29	
2	Fall	1943	1.0	1946	0.6	3	(0.4)	(40)	(13.3)	3	
3	Rise	1946	0.6	1974	5.0	28	4.4	733	26.0	27	
4	Fall	1974	5.0	1976	4.3	2	(0.7)	(14)	(7.0)	2	
5	Rise	1976	4.3	1981	5.1	5	0.8	19	3.8	5	
6	Fall	1981	5.1	1983	4.2	2	(0.9)	(18)	(9.0)	2	
7	Rise	1983	4.2	1989	5.6	6	1.4	33	5.5	6	
8	Fall	1989	5.6	1994	3.6	5	(2.0)	(36)	(7.2)	5	
9	Rise	1994	3.6	2008	6.0	14	2.4	67	4.8	13	
10	Fall	2008	6.0	2009	5.3	1	(0.7)	(12)	(12.0)	1	
11	Rise	2009	5.3	2011	7.3	2	2.0	38	19	2	
12	Fall	2011	7.3	2016	5.7	5	(1.6)	(22)	(4.4)	5	
13	Rise?	2016	5.7	2017	5.8	1+?	?.?	??	?.?	1+?	
Proportion of time spent in growth and time spent in downturn:										82	18

A surprising Correlation (Not!) or mere Coincidence?

- Six global recessions since 1970 (IMF) when global annual GDP growth rate of 3.0% or less is equivalent to global recession:
- Global Recession: 1974-75, 1980-83, 1990-93, 1998, 2001-02, 2008-09
- Fluorspar volume: 5.0-4.2 5.1-4.2 5.6-4.1 4.1 4.2-4.1 6.0-5.3 mta
- Precision: a year either side. Is this coincidence or is there cause?
- Fluorspar volume 2011-2016: 7.3-5.7 but no global recession.

A surprising Correlation (Not!) or mere Coincidence

- No global recession since 2009 to coincide with 5 years fluorspar fall 2011 (7.3mt) to 2016 (5.7mt). What's going on? China slowing & FCs regulation a double whammy.
- What would the effect of recession have been on fluorspar markets had one occurred in the five-year period and what might its future cause be?
- Fear over Chinese debt/slowing economy, protectionist rumblings, N. Korea, M. East, alleged asset bubbles poised to pop (eg Tech Shares), end of easy money? But these are not new and each in themselves would not likely cause recession or derail the long run bull stock market!
- What would derail a bull market and cause recession are real risks that lurk where no-one else looks so packing surprise punch or, more likely perhaps, reality kicking in to not match growth aspirations. Such causes could include:
 - Major Monetary Policy mistake
 - Inverted Chinese Yield Curve
 - Global Trade War
 - US Fiscal Policy
- Undoubtedly there are others that may in themselves be small events but might spark a chaotic domino effect. Sound familiar?

World Fluorspar Production By Region 1950 -2016 (mt)

	1950	1960	1970	1989	1994	2008	2012	2014	2016
Total	0.84	2.03	4.4	5.56	3.81	6.08	6.95	6.52	5.74
Acid	...	...	...	3.12	2.37	3.97	3.73	3.66	3.68
China	-	0.25	0.27	1.70	2.00	3.30	4.20	4.00	3.70
Mexico	0.07	0.36	0.88	0.78	0.24	1.06	1.24	1.11	0.66
W Europe	0.33	0.71	1.37	0.76	0.43	0.23	0.21	0.23	0.18
Russia/Mongolia	0.08	0.23	0.48	1.05	0.46	0.70	0.68	0.49	0.31
South Africa	-	0.10	0.18	0.37	0.17	0.30	0.17	0.17	0.23
Other Africa	...	...	...	...	...	0.28	0.27	0.23	0.08
US/Canada	0.33	0.28	0.41	0.12	0.05	-	-	-	-
Thailand			0.32	0.10	0.02	0.02	0.02	0.02	0.06
S America	...	...	...	0.12	0.09	0.08	0.06	0.06	0.06

Who shared fluorspar production rollercoaster? By Region %

World rank

1
2
3

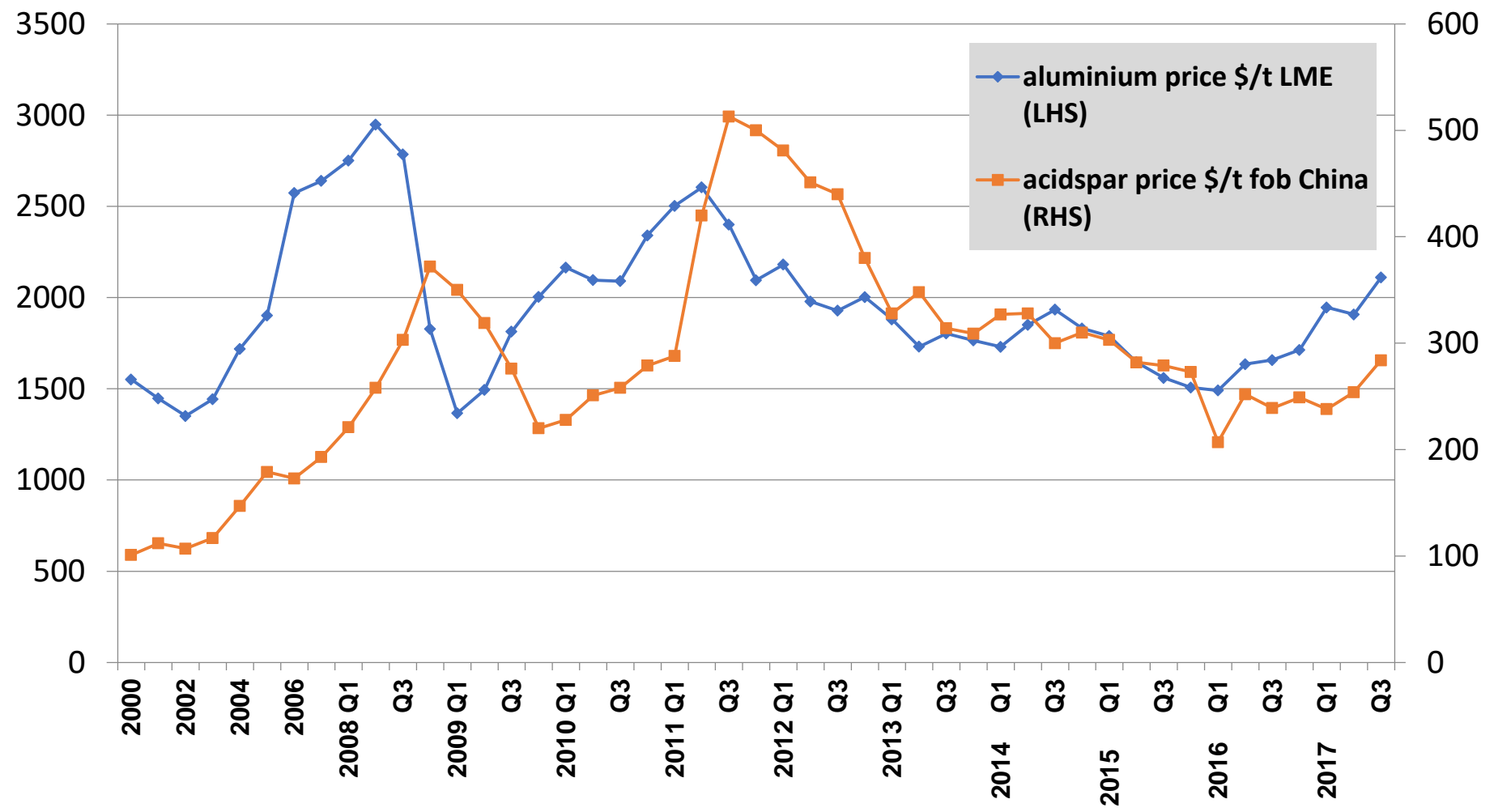
	1950	1960	1970	1989	1994	2008	2012	2014	2016
Total Mt	0.84	2.03	4.40	5.56	3.81	6.08	6.95	6.52	5.74
Acidspar	---	---	---	56.1	62.2	65.3	53.7	56.1	64.1
China	--	12.3	6.1	30.6	52.5	54.3	60.4	61.3	64.5
Mexico	8.3	17.7	20.0	14.0	6.3	17.4	17.8	17.0	11.5
W Euro	39.3	35.0	31.1	13.7	11.3	3.8	3.0	3.5	3.1
Rus/Mon	9.5	11.3	10.9	18.9	12.1	11.5	9.8	7.5	5.4
S Africa	--	4.9	4.1	6.7	4.5	4.9	2.4	2.6	4.0
O Africa	--	--	--	--	--	4.6	3.9	3.5	1.4
US/Can	39.3	13.8	9.3	2.2	1.3	--	-	--	--
Thailand	--	--	7.3	1.8	0.5	0.3	0.3	0.3	1.0
S Amer	--	--	--	2.2	2.4	1.3	0.9	0.9	1.0
Others	3.5	4.9	11.1	10.1	9.2	1.8	1.4	3.2	8.0

World Fluorspar Consumption

Region	1993		2003		2008		2012		2014		2016	
	<i>mt</i>	%	<i>mt</i>	%	<i>mt</i>	%	<i>mt</i>	%	<i>mt</i>	%	<i>mt</i>	%
China	0.71	19.5	1.29	27.5	2.64	42.7	3.87	54.7	3.75	58.4	3.42	59.1
N America	0.75	20.5	1.00	21.3	1.00	16.2	0.98	13.9	0.78	12.2	0.48	*8.2
EU 28	0.87	23.8	0.90	19.2	0.94	15.2	0.88	12.5	0.83	12.9	0.82	14.2
Other Asia	0.82	22.5	0.85	18.1	0.76	12.3	0.54	7.6	0.54	8.4	0.53	9.2
Russia/CIS	0.38	10.4	0.42	9.0	0.64	10.4	0.53	7.5	0.35	5.5	0.30	5.2
S America	0.07	1.9	0.09	1.9	0.12	1.9	0.10	1.4	0.11	1.7	0.10	1.7
Africa	0.05	1.4	0.14	3.0	0.08	1.3	0.17	2.4	0.06	0.9	0.14	2.4
TOTAL	3.65	100	4.69	100	6.18	100	7.07	100	6.42	100	5.79	100
Acidspar	2.25	61.6	3.09	65.9	4.05	65.3	3.58	51.1	3.43	53.3	3.79	65.5



Acidspar & Aluminium Prices 2000-2017 \$US/t





Today's Supply and Demand Scenario

Observations based on available data and published information

- Overall world growth continues sluggish, demand down white goods and cars, commodity prices depressed
- Market peaked 2011 at 7.3Mt (3.9Mt acidspar)
- 6.5Mt in 2013/2014 (3.5Mt acidspar) in 2013
- 5.8Mt 2016 (3.8Mt acidspar)
- Output down Mongolia, China, Mexico and Africa
- Shutdowns Bulgaria, Kenya, Namibia, Russia, S Africa
- New entrants Afghanistan, Germany, Spain, Thailand, Vietnam
- China metspar imports up, and also acidspar! But still a net exporter!
- China exports increasing levels of HF and AlF_3
- China environmental pressures on pollution (tailings dams, HF) but fluorspar is a *"favoured"* commodity

Entries and Exits (ex China) 2013-2016

Company	Project	Location	Date	Capacity	
New Fluorspar Producers					
Masan	Nui Phao	Vietnam	Q4 2014	220,000	Acidspar
Minera De Órgiva	Órgiva	Spain	2015	30,000	Metspar
Nickelhütte Aue	Aue	Germany	2014	40,000	Acidspar
Amania Mining	Bakhud	Afghanistan	2015	60,000	Mixed
Canada Fluorspar	St Lawrence	Canada re-entry	Q4 2017	200,000	Acidspar
TOTAL				550,000	
Shut Down or Mothballed Producers					
Rusal	Yaroslavsky	Russia	Q2 2013	120,000	Acidspar
Okorusu Fluorspar	Okorusu	Namibia	Q4 2013	120,000	Acidspar
Fluormin-Sallies	Witkop	South Africa	2013	100,000	Acid/Met
Solvay	Chiprovtsi	Bulgaria	2015	50,000	Acidspar
Kenya Fluorspar	Eldoret	Kenya	Q2 2016	120,000	Acidspar
TOTAL				510,000	

Potential new fluorspar projects (ex China) 2017-2020

Company	Project	Location	Start-up	Funded (≥80%)	Unfunded
SepFluor	Nokeng	South Africa	Q1 2019	210,000	
Tertiary Mins*	Storuman	Sweden	??		150,000
SA Fluorite	Doornhoek	S Africa	??		150,000
Total				210,000	300,000

*Exploitation re-assessment progressing. Also has projects in Norway (early stage) and Nevada (scoping study ongoing)

An uncertain future as always: Supply Security

- **China progress:**
 - availability, reliability, national focus
 - President Xi Jinping confirmation and next 5 year plan to restore China to greatness and extend influence on global affairs and enhance green credentials. Jinping Thought written.
 - Is all that positive for fluorspar growth globally, and in China?
- **Proximal resource development:** Developing mines nearer to markets.
- **Supply chain disruption:** Transportation shortages, conflict
- **Criticality:** Impact of recognising fluorspar as a critical raw material following the EC's 2008 Raw Materials Initiative first published 2011 and now in its third iteration (1917)

An uncertain future as always: Supply Security

➤ Vertical integration:

- In and out of fashion for chemical companies acquiring mines assets, e.g.
 - Solvay: Namibia & Bulgaria;
 - Minersa: Spain & S Africa;
 - Mexichem: Mexico;
 - China Yingpeng Chemical: China
 - Fluorsid: UK

- *Protects* against adverse fluorspar price movement but ties up capital that might better be used when prices fall.

- Downstream integration for higher profit margins, needs more research investment, and deeper customer relations. Internal transfer pricing in danger of losing sight of free market prices.

- Cultural clash between miners and chemists.



An uncertain future as always: Global Warming Potential & NIK

- Flat at best for non-captive fluorochemicals beyond 2020 dependent upon developing countries
- Greatest pressure in Europe for GWP measures, possibly China may step up, USA trailing
- Will the fourth generation FCs, (HFOs) backed by EU legislation in 2017, have sufficient green credentials to be the lasting solution given their vastly superior GWP rating (**4** for HFO 1234YF v **1,430** for HFC 134a) but higher risk of flammability **on a 1-3 scale?** Following Daimler's report of flame propagation and explosion in a 2012 crash test CO₂ is still in the wings.
- 2008: Honeywell & DuPont/Chemours worked on HFOs since HFCs became problematic.
- 2014: EU F Gas Regulations for HFC reductions by 2030.
- 2016: Kigali agreement: phase out HFCs by 85% by 2045
- 2017: In the USA arguments continue over the legality of the EPA's 2015 decision to ban HFCs in favour of HFOs where recent court decisions are allowing both to continue for the moment.
- CO₂ refrigeration and air-conditioning: NIK not so effective in hot climates presently
- Fluoropolymer growth: counterbalancing capability?
- Aluminium growth: counterbalancing capability?
- New technology: Li-ion batteries, solar panels, electronics: counterbalancing capability?



An uncertain future as always: Fluorosilicic Acid

- Potential 3.7mta from phosphoric acid manufacture based on the mineral, apatite
- Disadvantage is high capital and processing cost barrier and proximity to user
- Presently supplies 15-20% of global AlF_3 market
- China use in HF manufacture encouraged politically -- now producing 100ktpa HF from three FSA plants
- Political pressure to utilise waste stream FSA in China

So what is the vision for fluorspar?

- Now in uncharted territory with 5 years decline post 2011 peak but without global recession. Recession is inevitable at some point.
- When, is not visible today although the advanced stages of a long-run bull market are evident. Without substantial demand growth, any recession will accelerate the average 4.4% per year fall since the 2011 peak, maybe towards 4.0 mt which has been a floor since 1970.
- Much depends on the fourth generation family of fluorochemicals (HFOs), the uptake by emerging technologies to offset any NIK replacement, and the length and depth of the next recession.
- China, where unpredictability appears the norm, is likely to increase level of imports although presently remains a nett exporter.
- Producers need to be light on their feet, avoid overstocks and sky-high capital borrowing, secure long term customer relationships, minimise distance to market for juniors, maximise long term mine life and, crucially, sustain and improve quality.



Fluorspar to 2018 and beyond

Gerry Clarke & Peter Huxtable

- Justifiable optimism
- Fledgling upturn continues through 2020
- China's "green" march boosts fluorspar imports over time
- South Africa resurgence medium to longer term
- Regulatory attention on HFO chemicals flammability
- Beware & prepare for (historically overdue?) recession
- Fluorspar continues as prime source of F although growth curtailed by continuing FSA developments

Thank You