

Drilling grade barite: the global outlook

By Andrew Scogings

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As unconventional shale oil and gas exploration and development continues at pace in North America and further afield, Andrew Scogings, Industrial Minerals Consultant, provides an executive summary of IM's upcoming research report on drilling-grade barite.

Barite (barytes) is naturally-occurring barium sulphate (BaSO_4) and is the predominant barium mineral used for industrial purposes. The mineral occurs in veins, stratiform beds and lenses in addition to residual deposits. The largest deposits currently mined are stratiform beds in China, India and the US. Barite is utilised primarily for its high specific gravity (SG 4.5) in addition to its chemical and physical inertness, relative softness and very low solubility.

Mineral weighting alternatives to barite include celestite, calcium carbonate, ilmenite and synthetic hematite. Apart from calcium carbonate, none of these mineral substitutes has had a major impact on the barite drilling mud industry. Cesium formate brines (SG 2.2) have been developed for challenging high pressure, high temperature (HPHT) drilling operations and are produced from pollucite at the TANCO lithium mine in Manitoba, Canada.

Table 1: American Petroleum Institute barite specifications

API 13A - Barite physical and chemical requirements	
Requirement	Standard
Density (Clause 7)	4.20 g/ml, minimum
Density (Clause 20)	4.10 g/ml, minimum
Water-soluble alkaline earth metals, as calcium	250 mg/kg, maximum
Residue greater than 75 m	Maximum mass fraction 3.0%
Particles less than 6 m in equivalent spherical diameter	Maximum mass fraction 30%

Source: API Specification 13A, August 2014

Table 2: Drilling grade barite prices, December 2014

	Low \$	High \$
Barite, Drilling grade, ground SG 4.22, bagged, FOB Morocco, \$/tonne	110	170
Barite, Drilling grade unground lump, OCMA/API, Bulk, SG 4.20, FOB Chennai, \$/tonne	138	145
Barite, Drilling grade, API unground lump, SG 4.20, FOB China, \$/tonne	112	128
Barite, Drilling grade unground lump, OCMA/API bulk, SG 4.10 FOB Chennai, \$/tonne	110	125
Barite, Drilling grade, API unground lump, SG 4.10, FOB China, \$/tonne	109	113
Barite, unground lump, OCMA/API bulk, SG 4.20, FOB Morocco, \$/tonne	115	127
Barite, API, lump, CIF Gulf Coast, Chinese, \$/tonne	145	160

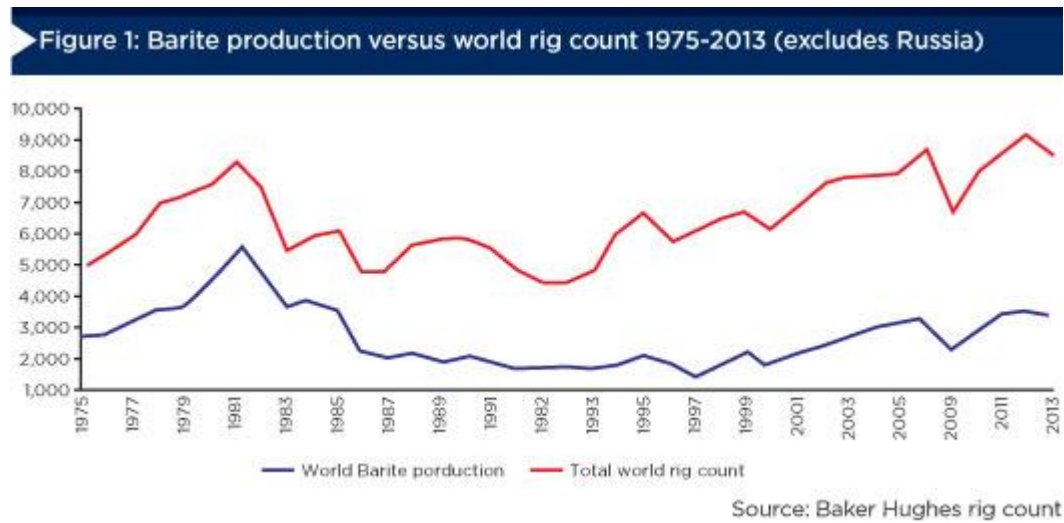
Source: IM

Reserves, production and consumption

No reliable information is available with regard to the total world reserves of barite, however the US Geological Survey (USGS) estimates 350m tonnes of reserves of which China, India and Kazakhstan are claimed to account for 219m tonnes (63%). This global reserve base should be sufficient for more than 40 years' life at current production rate and prices.

Significant deposits of barite have been identified (but not quantified) in northern Alaska, although these have not yet been brought to account, probably due to remote location. In terms of public reporting according to

international codes such as JORC and NI 43-101, it is cautioned that the reserves reported by USGS are unlikely to meet current criteria as either resources or reserves especially in terms of geological continuity and economic viability.

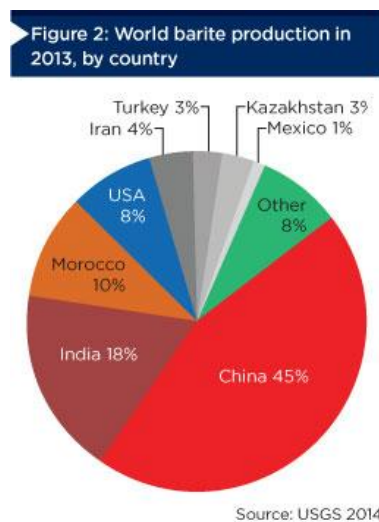


Mining and processing

The geometry and type of barite deposit affects mining economics and processing complexity. Briefly, vein deposits have complex geometry and may often be extracted from surface or underground as a co-product of lead or zinc mining. Residual deposits are shallow enough to be mined opencast using dozers, excavators or front end loaders. Bedded barite deposits are more extensive and have more consistent grades; these can be exploited by large-scale open pit methods, followed by relatively simple processing.

Barite is extracted by both surface and underground mining, generally followed by simple physical processing methods to produce correctly sized product and to

remove extraneous (mainly silicate gangue) materials. Flotation may be used to separate barite from finely intergrown gangue minerals.



Reserves, production and consumption

World barite production is directly linked to oil and gas-well drilling activity (*Figure 1*) and has increased from around 5m tpa in the 1990s to around 8.5m tonnes in 2013. Globally, more than 80% of barite produced is used as a weighting agent for drilling fluids in oil and gas exploration.

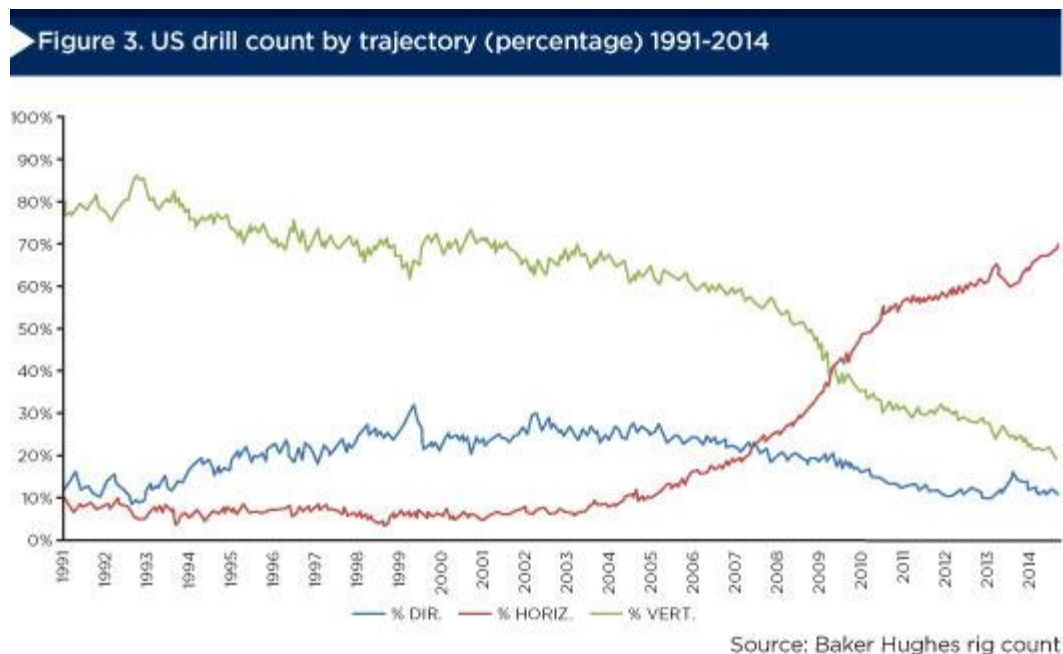
When considering barite reserves suitable for use in drilling fluids, there are relatively few major sources with China, India, the US and Morocco, Mexico and Turkey accounting for about 80% of global production. China accounts for around 45% of world production with India, US, Morocco and Turkey making up a further 35% (*Figure 2*).

The US is the largest barite consumer at around 3m tpa, accounting for more than 30% of annual shipments. It is followed by China, which consumes around 1.1m tpa barite. The global barite markets are skewed; for example 70% of European domestic production is for added-value manufacturing sectors such as chemical and filler industries.

In contrast, the US uses over 95% of its barite output for the oil drilling industry, highlighting a general correlation between rig activity and barite consumption, though this ratio has been affected over the past decade due to increased horizontal drilling, which in the US currently accounts for 70% of compared with only 15% in 2004 (*Figure 3*). It appears that increased drilling of horizontal holes per rig platform has resulted in higher consumption of barite per rig.

There are relatively few large global manufacturers of drilling fluids, including MI SWACO, Halliburton, Baker Hughes and Newpark, which dominate the field through a network of global subsidiaries.

In terms of drilling location, the Gulf of Mexico (GoM) is the largest consumer of drilling-grade barite in the world, and for a number of years this was dominated by imports of Chinese lump barite to grinding mills in various coastal locations. Indian barite supply has risen and is now believed to account for nearly one quarter of imports to the GoM.



Industry specifications

The American Petroleum Institute (API) introduced a new barite grade (SG 4.1) in August 2010, in addition to the long-standing 4.2 specification. The intention was not to replace the 4.2 grade, but to provide the end-user with choice as to which material to use. This change was driven in part by a shortage of SG 4.2 barite, especially

from mines in Nevada, which is the US's primary domestic barite producing region. Drilling-grade barite is specified by the API and must meet certain SG, chemical and sizing requirements (*Table 1*).

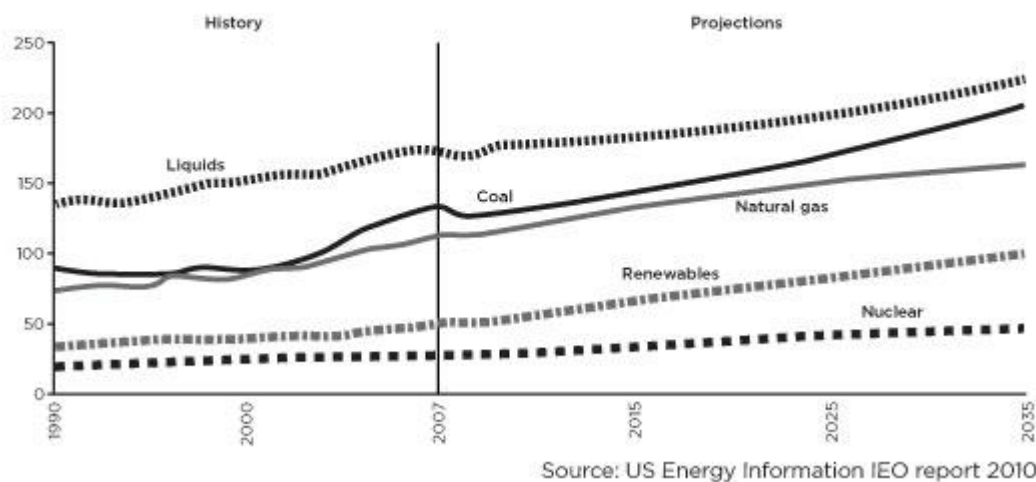
Although not an API specification, drilling companies have started to focus on heavy metal content in particular mercury (Hg <1ppm) and cadmium (Cd <3ppm) as specified by the US Environmental Protection Agency (EPA) for the GoM. Additional heavy metals may also be taken into account for example silver (Ag), arsenic (As), chromium (Cr), copper (Cu), lead (Pb), selenium (Se) and zinc (Zn), although there are no set limits for oilfield applications.

Barite prices

Barite prices are linked to purity and in the case of drilling-grade barite, the SG as illustrated by current FOB Chinese prices where a premium of approximately 15% applies to SG 4.2 compared with SG 4.1. There is also a variation in price according to source, as illustrated by current Indian lump FOB being about 10% higher than China.

Barite prices remained relatively steady until approximately 2006 relative to 1995 dollars, after which they increased rapidly until around 2012 and have currently fallen back slightly in 2014, but still some 200% above the inflated 1995 dollar base. This sharp increase resulted from a number of factors including rationalisation and consolidation of the Chinese barite mines, in addition to highly intensified US onshore drilling for tight oil and gas which placed further pressure on suppliers.

Figure 4. Predicted growth in global fuel demand to 2035, world marketed energy use in quadrillion British thermal units (Btu)



Logistics

Crude (lumpy) barite is shipped globally by sea, mainly from China and India to milling plants strategically located close to oil and gas drilling hotspots such as the Gulf States, the North Sea and the US GoM. Key export cities are Zhenjiang and Fangcheng in China; Krishnapatnam, Chennai and Puducherry in India, Buchanan in Liberia and Ensenada and Guayamas in Mexico. Major import destinations are New Orleans, Galveston, Corpus Christi and Brownsville in the southern US, Ijmuiden in Holland and Dammam in Saudi Arabia.

Milled API-grade barite is shipped to numerous destinations both from barite producing countries such as India, China, Morocco, US, Turkey, Kazakhstan, Mexico and Vietnam, in addition to barite millers in Holland and the US.

Barite producers may either ship directly to their customers, or ship via intermediaries or agents who specialise in barite sourcing, shipping and logistics and sales partnerships.

Outlook and forecasts

Liquids remain the world's largest energy source throughout the IEO 2010 Reference case projection, given their importance in the transportation and industrial end-use sectors. World use of liquids and other petroleum in the IEO2010 Reference case grows from 86.1m barrels per day (bpd) in 2007 to 92.1m bpd in 2020, 103.9m bpd in 2030, and 110.6m bpd in 2035.

This growth in petroleum usage suggests that petroleum exploration will continue to grow and, along with it, barite consumption, especially as more drilling has to be done per unit of oil as hydrocarbon discoveries become smaller and less productive with time. However, the recent sharp drop in crude oil prices may result in decreased exploration in the short term, similar to the trend seen in 2009 immediately after the Global Financial Crisis.

Projecting global barite production based on 1998 (6m tonnes) to 2013 (8.2m tonnes) indicates that 9.5 to 10m tpa may not be an unrealistic market by 2020, tempered somewhat by the recent drop in oil prices.

*This feature serves as an executive summary of **IM**'s Drilling Grade Barite report, available to purchase from January 2015. To order your copy or to receive a report brochure please contact Emma Hughes, Special Projects Editor, on ehughes@indmin.com or +44 (0) 207 827 6449.*