# Chromite Market Summary

There are three main types of chromite in nature: high-chromium chromite, high-iron chromite and high-aluminum chromite used as refractory minerals. The application of chromite products is more interchangeable than in the past with improved processing technologies. At one time only raw "lump" chromite was used in smelters to produce ferrochrome for stainless steel production. With the reduction of lump chromite quality, fine grained chromite is being processed (agglomerated and pelletized, or directly reduced in plasma arc furnaces) to produce higher quality ferrochrome.

The production of stainless steel and similar specialty steel products is not possible without the use of the mineral chromite, the world's principal source of chromium metal. The world chromite market consumes approximately 22 million tonnes of chromite per year (2008), 90% of which is consumed as ferrochrome dedicated to stainless steel production. By 2013 world chromite consumption is expected to increase to about 22.3 million tonnes per annum, following the recent global recession. Since 2000 chromite consumption has grown at a rate of about 5.4% per year until 2007. This growth was driven principally by Chinese consumption, accounting for almost one-third of world demand. The production of ferro-chrome requires about 2.4-2.5 tonnes of chromite per tonne of ferrochrome, and the production of standard grade stainless steel requires about 0.66 tonnes of chromite per tonne of stainless steel.

Minor chromite production/consumption is dedicated to the refractory and foundry chromite markets (4%) and the chemical chromium business (2-3%). The demand for refractory grade chromite has continued to decrease since 1970 with the introduction of new smelting methods and the health concern over hexavalent chromium. Foundry grade chromite consumption has steadily increased with its replacement of radioactive zircon and the demand for high quality metal castings. The use of chemical grade chromium continues to grow steadily with its use in leather tanning and electroplating. World consumption of these three chromite products totals less than 1.2 million tonnes per year.

Seventy percent (70%) of the world's chromite is produced in four countries: South Africa (40%), Kazakhstan, Zimbabwe and India. The best quality chromite occurs in Kazakhstan. The quality of chromite is measured primarily on the contained chromium content and the chromium to iron ratio of the oxide spinel structured mineral. Most chromite is mined underground by room and pillar method, the ore is brought to the surface and processed by crushing, screening, flotation and gravity processes prior to smelting or refining into appropriate end uses. Around 70% of global chromite production is consumed domestically in ferro-chrome production in the country of origin.

Foundry grade chromite must pass a number of physical and chemical requirements in order to meet the tight specifications required by metal foundries. Chemical grade chromite has high chromium content, typically greater than 45% chromium oxide, Cr2O3, and low concentrations of adverse trace elements. Ferrochrome production is energy intensive, requiring between 3200-4500 kilowatt hours of electricity per tonne of ferrochrome, resulting from smelting chromite ore at 1200 to 1600 degrees centigrade. This represents nearly one-third (1/3) of the cost of producing ferrochrome. Several grades of ferrochrome are produced depending on the chromium content and carbon content. High carbon ferrochrome contains about 60% chromium, while charge chrome contains 50-55% chrome and more carbon. Although most production is in South Africa, due to recent power limitations production ceilings have been reached. By 2021 South Africa is expected to produce 44% of the world's ferrochrome, while China is expected to produce about 18%. World production of ferrochrome is at about 72% of overall production capacity. Most of Kazakhstan's production is dedicated to high-carbon ferrochrome delivered to China. Russia is currently increasing capacity of ferrochrome, as is India. Most production of chromite in India is dedicated to domestic production of ferrochrome.

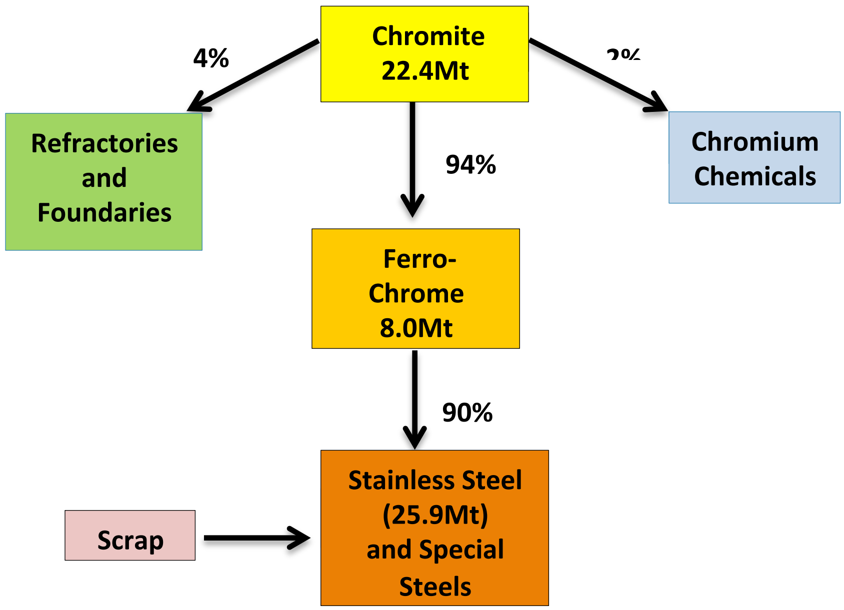
Potential future producers include Canada (James Bay Ontario deposit); China (remote Tibetan deposits), Turkey, and Zimbabwe (10% of world resource). The principal importers of chromite include China (77%) and Russia (5%). Most of South Africa's exports go to China; Kazakhstan's' exports go mainly to China (76%) and Russia (24%); and Turkey's production goes to China (59%) and Russia (21%).

**Foundry grade chromium products**

World consumption of foundry grade chromite (FGR) totaled about 600,000 tonnes in 2007, most of which was sourced from South Africa. Chromite is preferred over silica sand and other foundry products due to the quality of castings and its non-radioactive composition. Besides stringent chemical compositional character, the size, shape and acid consumption rate are critical for this type of premium chromite product. Typically foundry grade sand must have a chemical composition exceeding 44% chromium oxide, no more than 27% iron and less than 4% silica. Ninety percent of the chromite sand must range from 0.39 to 0.70 millimeters in size. The product must have low magnesium and aluminum contents and an AFS number (American Foundrymen Society) average grain size distribution number not less than AFS-GFN # 51. Typically, less than 60% of chromite mined and processed is recovered as foundry grade chromite (67% of spiral product). The cost of producing foundry grade chromite is considerably greater than the cost of producing sintered metallurgical grade chromite. High quality chromite foundry sand is replacing/substituting for zircon (priced ~ $1,000/tonne). Some of the New Caledonia chromite deposits appear to meet foundry grade chromite specifications at the early prospect stage.

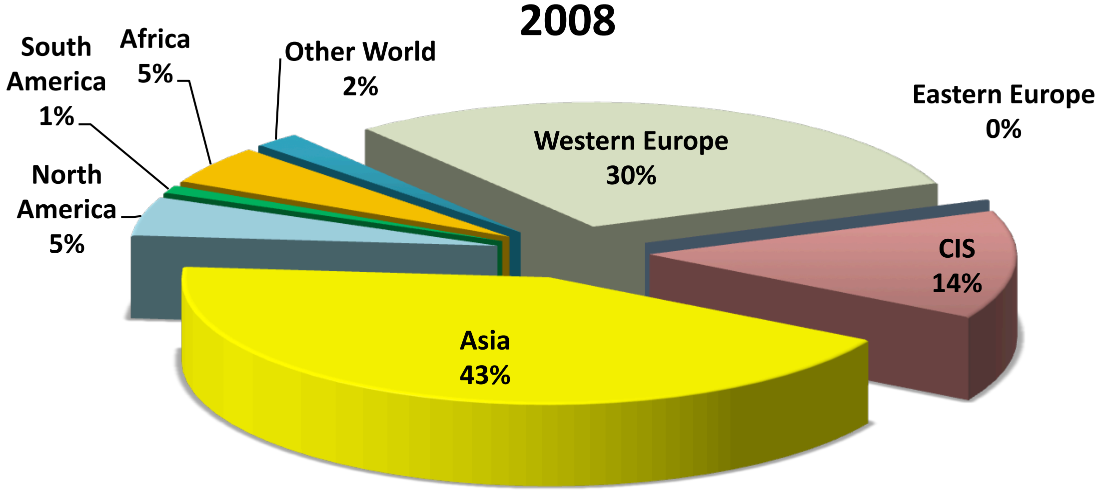
During peak chromite pricing in early 2008, foundry grade sand sold for several times the peak price of metallurgical grade chromite (MGR). Current market pricing of this specialty product remains strong (+$600/T), due to the increasing demand for chromite as a replacement for zircon foundry product. The annual production of foundry chromite is required for the pouring and production of about 6.4 million tonnes of metal castings.

## World Chromite Market 2008

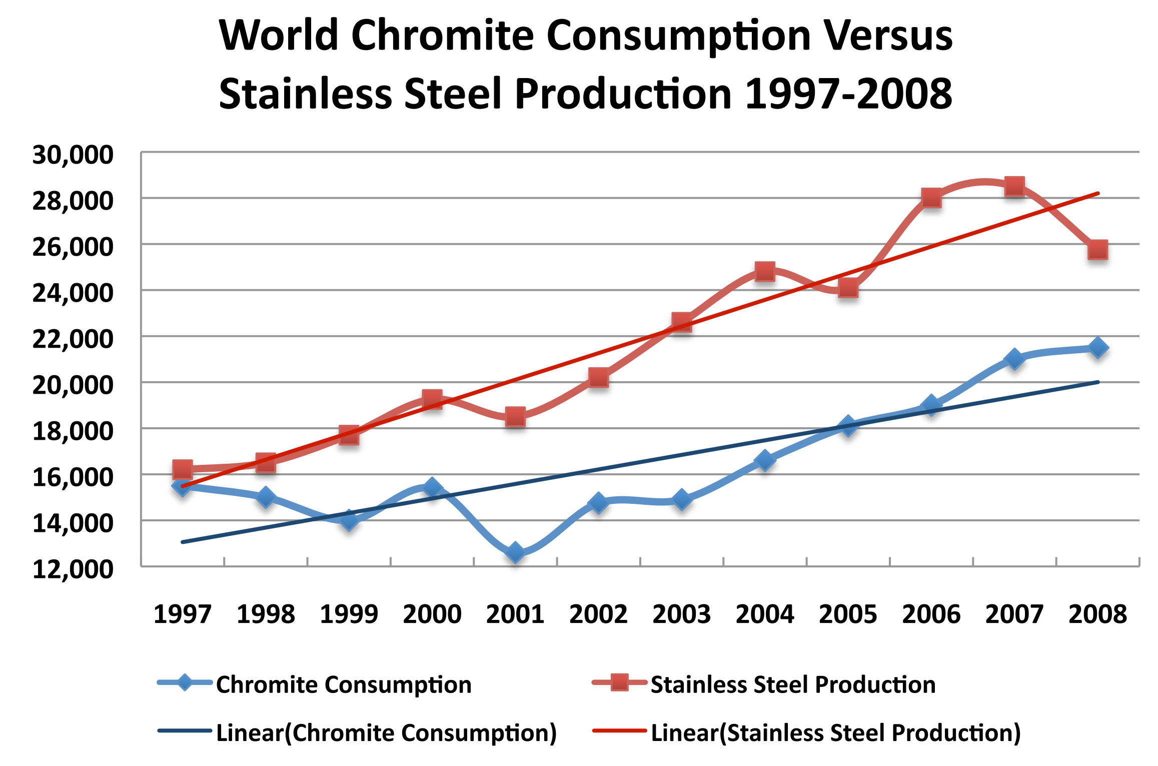



*Roskill 2009*

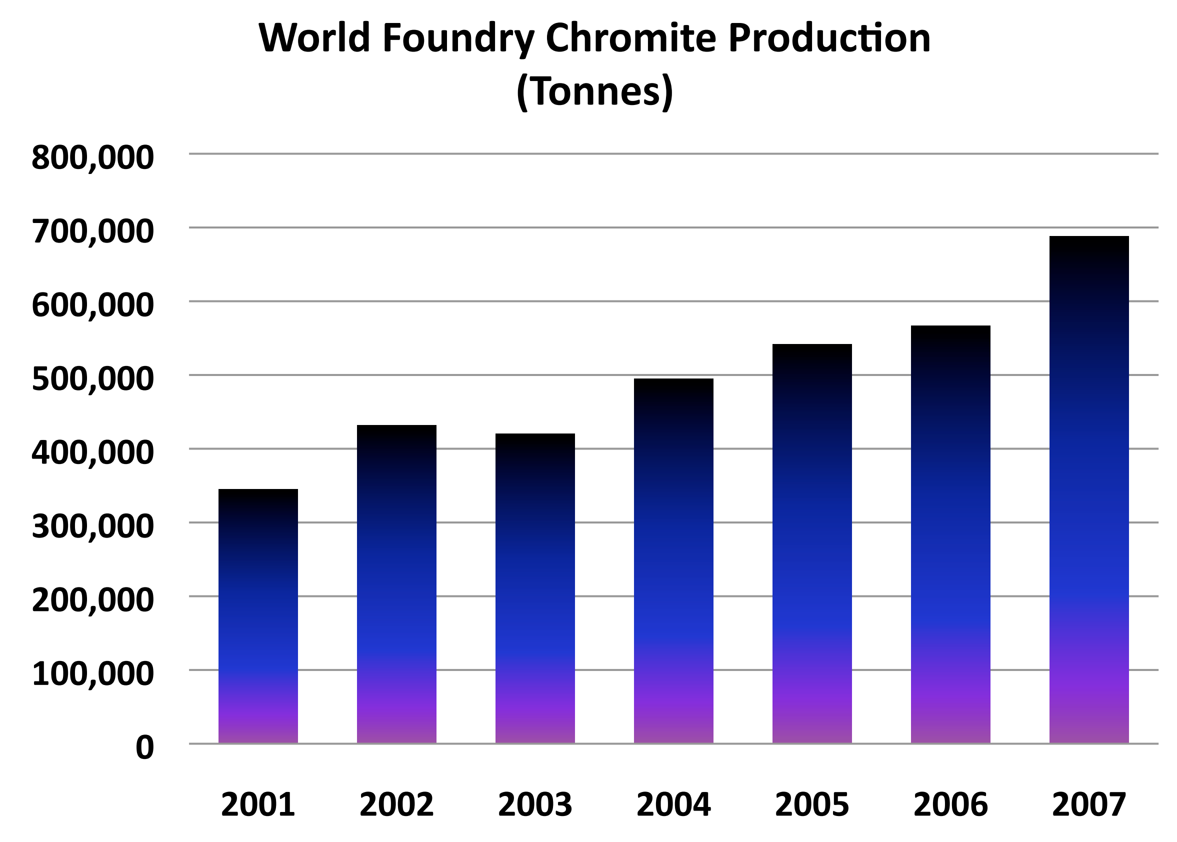
## World Regional Ferrochrome Consumption 2008




*Roskill 2009*



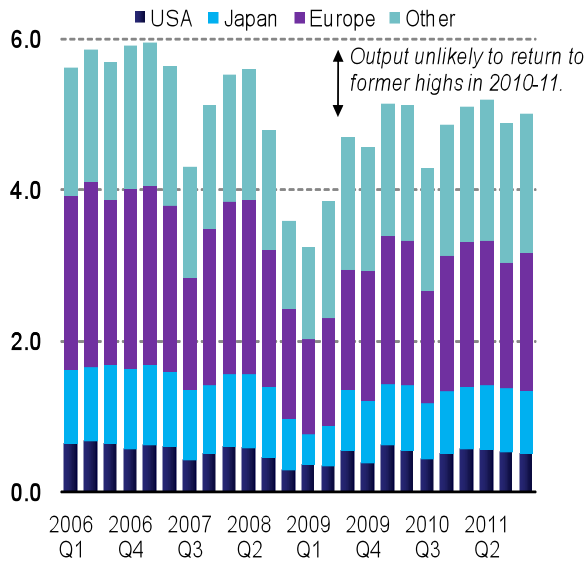

*Roskill 2009*



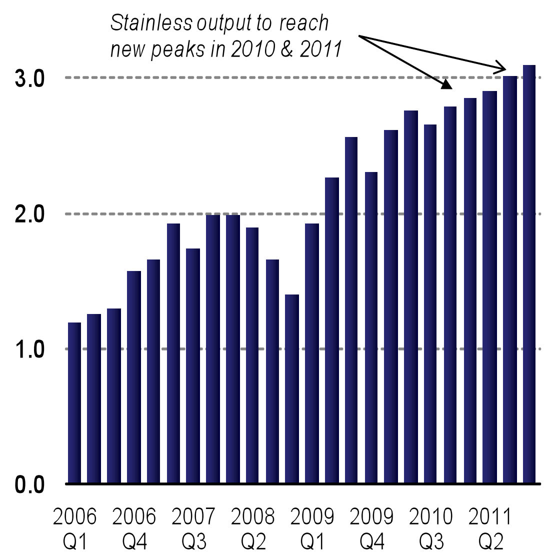

*Roskill 2009*

## There is marked variation between regions

**Stainless production outside China, quarterly, m tonnes, 2006-2011**




**Stainless production in China, quarterly, m tonnes, 2006-2011**




Data: CRU Analysis

## Summary of prospects for stainless steel production

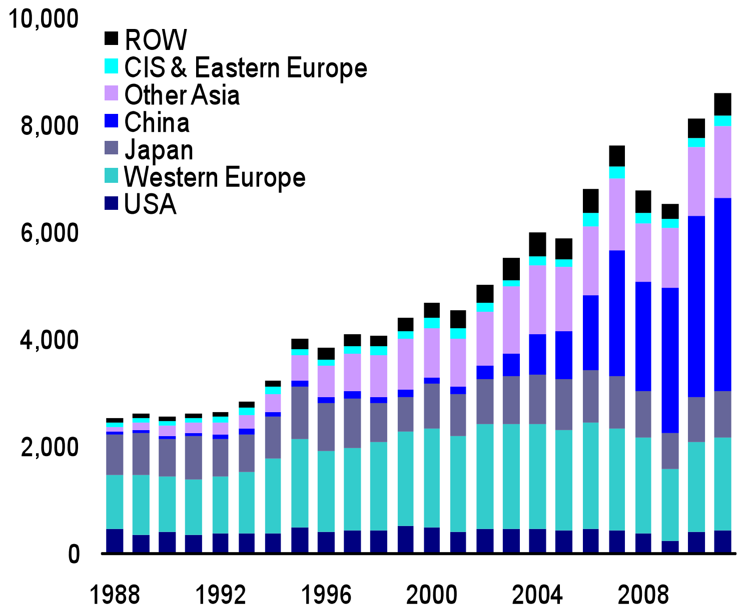
**Stainless steel melted production by region, 2009-2011, m tonnes and % change**

| | 2009 | % change | 2010 | % change | 2011 | % change |
|---|---|---|---|---|---|---|
| N. America | 1.6 | *-16.0%* | 2.1 | *+30.1%* | 2.2 | *+3.6%* |
| Europe | 6.1 | *-24.2%* | 7.3 | *+20.0%* | 7.5 | *+2.6%* |
| China | 9.0 | *+30.7%* | 10.8 | *+19.5%* | 11.9 | *+10.2%* |
| Rest of Asia | 7.7 | *-10.3%* | 8.9 | *+15.1%* | 9.3 | *+4.9%* |
| Rest of World | 0.9 | *-1.4%* | 1.1 | *+18.2%* | 1.2 | *+7.7%* |
| **Total World** | **25.3** | ***-3.9%*** | **30.2** | ***+18.9%*** | **32.1** | ***+6.2%*** |

Data: CRU Analysis

# Ferrochrome consumption has picked-up strongly in 2010

**World consumption of ferrochrome, '000t, 1988-2011**



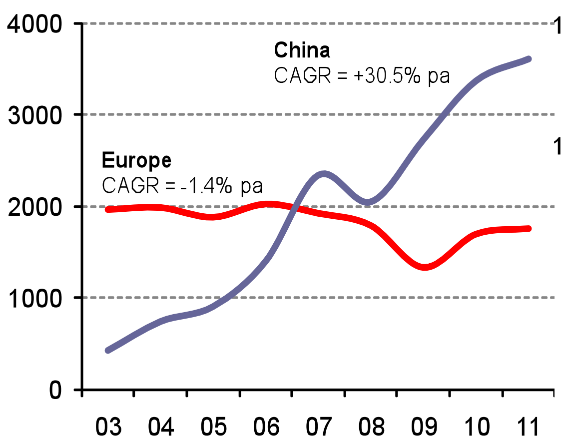

Data: CRU Analysis

**Key Points**

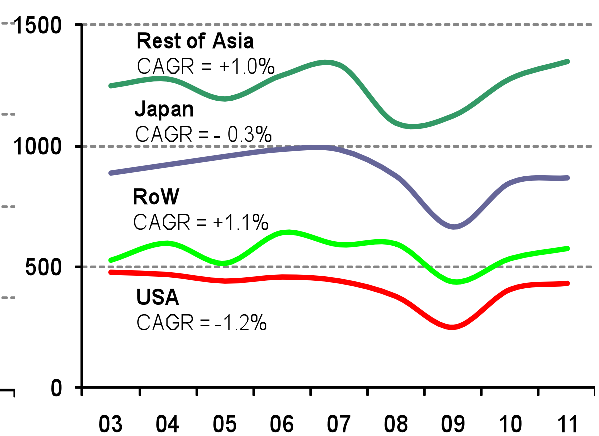
- In 2009, world FeCr consumption fell by 3.5%, as the slump in demand from the non-stainless sectors (-13%) was partially offset by a modest upturn in offtake from the stainless industry (+1%).
- Last year, FeCr consumption in the stainless sector benefited from the recovery in Chinese stainless output as well as scrap shortages.
- This year, world consumption of FeCr is expected to rise by 24%, led by the stainless sector but also due to gains in offtake from the non-stainless end-uses.

# All regions should see an increase in ferrochrome consumption this year

**Ferrochrome consumption, Europe and China, '000 tonnes**




**Ferrochrome consumption, rest of world, '000 tonnes**




CAGR = Compound annual growth rate over years 2003-11

Data: CRU Analysis

## Much new capacity, especially in Africa, has been delayed

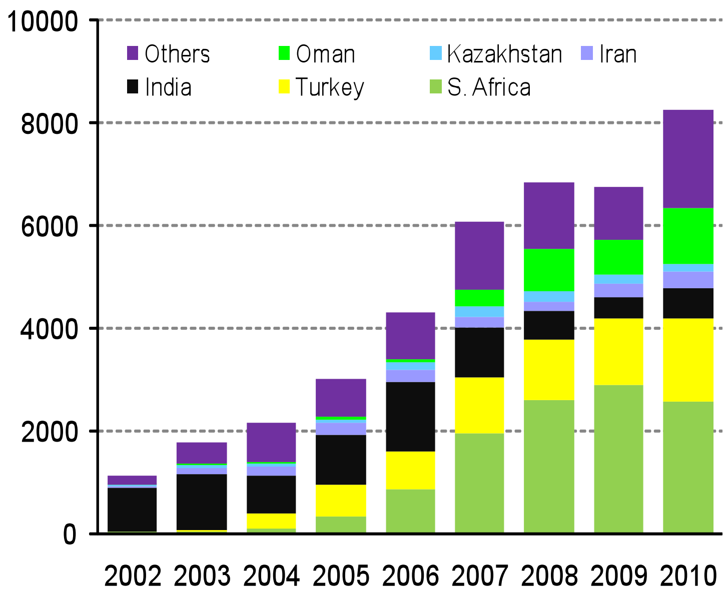
**Previously planned capacity that has been delayed or shelved**

| Company | Country | Capacity Increase | Status | Original Start-up Date | Current Start-up Date |
|---|---|---|---|---|---|
| Xstrata Lion II | S. Africa | 364 | Probable | 2010 | 2012 |
| Sam. Leopard | S. Africa | 1500 | Possible | 2011 | 2012-2015 |
| Hernic | S. Africa | 260 | Possible | 2011/2012 | Unknown |
| IFM Phase II | S. Africa | 400 | Possible | 2009 | 2012 |
| Tata Steel | S. Africa | 150 | Possible | 2010 | 2012 |
| Tharisa | S. Africa | 600 | Possible | 2011 | 2012 |
| ENRC - Aksu | Kazakhstan | 430 | Probable | 2010 | 2012 |
| Outokumpu | Finland | 235 | Possible | Q1 2011 | 2013 |
| Jindal Phases 1&2 | India | 300 | Possible | 2010 | 2011-2013 |
| IMFA Phase 3 | India | 70 | Possible | 2009/10 | 2011 |
| Rohit Ferro Tech | India | 55 | Possible | 2010 | 2011 |
| Balasore Alloys | India | 80 | Possible | End-2009 | 2013 |
| **Grand Total** | | **4,444** | | | |

Data: CRU Analysis *Of which 3.3m tonnes or 74% of this capacity was planned in S. Africa*

## South Africa supplies around 35% of China's chrome ore supplies

**Chinese imports of chrome ore, 2002-10***
**'000t gross weight**




Data: CRU Analysis ** 2010 is Q1 annualised*

**Key Points:**

- China looks likely to import over 8m tonnes of chrome ore this year.
- Around 2.6m tonnes of ore will come from South Africa (of which a sizeable quantity will be in the form of UG2).
- The remainder will come from a range of different countries including Turkey (1.6m tonnes), India (0.57m tonnes) and Oman (1m tonnes).
- South African UG2 is growing in importance as feed for Chinese FeCr producers. It has two big advantages:
  - Ample availability.
  - It carries a discount of up to 20% off lumpy LG6.