International Copper Study Group

International Lead & Zinc Study Group

International Nickel Study Group

# Joint Study of the Copper, Lead, Zinc and Nickel Industries in the Balkan Region

## August 2015

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## Introduction

After a number of years of significant political and economic change the production of lead, zinc, nickel and copper in the Balkan region has started to increase again. However, relatively little detailed research has been undertaken into the precise nature of these industry developments.

In order to properly evaluate the full extent and potential impact of current trends it was proposed the Study Groups undertake a study that will provide a comprehensive overview of the lead, zinc, copper and nickel industries in the region. The study presents an overview of industry structure and current output of these metals, ongoing and prospective projects, resources/reserves and exploration activities, and a brief review of the historic development of the industry in the region.

Countries covered in this report include Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Former Yugoslav Republic of (FYRO) Macedonia, Montenegro, Romania, Slovenia and Serbia. The work would be carried out within the secretariat using existing resources.

The structure of this report is as follows: Section I puts the Balkans copper industry in context by providing information on the national economy, including key sectors, trade flows, and the role of governments. Section II provides an in-depth examination of the Balkans copper industry, including background on the sector's historical development and detailed information on the regions copper production, usage, and trade. The report concludes with some comments on current and future issues and provides an outlook for the Balkans copper industry.

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## Table 1. Balkans Basic Facts

| | | Albania | Bosnia and Herzegovina | Bulgaria | Croatia | Greece | FYRO Macedonia | Montenegro | Romania | Serbia | Slovenia |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Population (mln people, 2014) | | 2.89 | 3.83 | 7.17 | 4.34 | 11.13 | 2.11 | 0.62 | 20.01 | 7.13 | 2.06 |
| Surface Area (sq km) | Total | 28,748 | 51,197 | 110,879 | 56,594 | 131,957 | 25,713 | 13,812 | 238,391 | 77,474 | 20,273 |
| | Land | 27,398 | 51,187 | 108,489 | 55,974 | 130,647 | 25,433 | 13,452 | 229,891 | 77,474 | 20,151 |
| | Water | 1,350 | 10 | 2,390 | 620 | 1,310 | 280 | 360 | 8,500 | - | 122 |
| GDP - current US$ (bln, 2013) | | 12.92 | 17.85 | 54.48 | 57.87 | 242.20 | 10.20 | 4.42 | 189.60 | 45.52 | 47.99 |
| GDP - Purchasing Power Parity, US$ (bln, 2013) | | 28.34 | 32.16 | 104.60 | 78.90 | 267.10 | 22.57 | 7.43 | 288.50 | 80.47 | 57.36 |
| GDP - composition by sector (2013) | Agriculture | 19.5%[1] | 8.1% | 6.7% | 5.0% | 3.5% | 18.8% | 6.3% [1] | 6.4% | 7.9% | 2.8% |
| | Industry | 12%[1] | 26.4% | 30.3% | 25.8% | 16.0% | 27.5% | 20.9% [1] | 34.2% | 31.8% | 28.9% |
| | Services | 68.5%[1] | 65.5% | 63.0% | 69.2% | 80.5% | 53.7% | 72.8% [1] | 59.4% | 60.3% | 68.3% |
| **Trade** | | | | | | | | | | | |
| Exports (f.o.b. USD bln, 2013 estimate) | | 2.33 | 5.69 | 29.52 | 11.85 | 36.59 | 4.27 | 0.49 [2] | 65.84 | 14.61 | 32.12 |
| Imports (f.o.b. USD bln, 2013 estimate) | | 4.88 | 10.30 | 34.32 | 20.93 | 62.15 | 6.60 | 2.35 [2] | 73.42 | 20.54 | 33.48 |
| **Consumption** | | | | | | | | | | | |
| Electricity consumption (bln KWh, 2013) | | 4.55 | 12.62 [1] | 30.46 [1] | 16.70 [1] | 56.40 [1] | 6.99 | 3.28 [3] | 52.36 [1] | 28.04 | 12.66 [1] |
| Telephones - main lines in use (mln, 2012) | | 0.31 | 0.88 | 2.25 | 1.64 | 5.46 | 0.41 | 0.16 | 4.68 | 2.98 | 0.83 |
| Telephones - mobile cellular (mln, 2012) | | 3.50 | 3.35 | 10.78 | 4.97 | 13.35 | 2.24 | 1.13 | 22.70 | 9.14 | 2.25 |
| Internet users (mln, 2009) | | 1.30 | 1.42 | 3.40 | 2.23 | 4.97 | 1.06 | 0.28 | 7.79 | 4.11 | 1.30 |
| Notes: | | [1] 2011 | [1] 2012 | [1] 2010 | [1] 2012 | [1] 2010 | | [1] 2011 [2] 2012 [3] 2010 | [1] 2012 | | [1] 2012 |

Source: CIA World Factbook 2014, the World Bank and the World Trade Organisation

**Table 2. Balkans GDP, constant prices % chg.**

| | Albania | Bosnia & Herzegovina | Bulgaria | Croatia | Greece | FYRO Macedonia | Montenegro | Romania | Serbia | Slovenia |
|---|---|---|---|---|---|---|---|---|---|---|
| **1990** | -10.0 | n/a | -9.1 | n/a | 0.0 | n/a | n/a | -5.6 | n/a | n/a |
| **1995** | 8.9 | n/a | -1.6 | 6.6 | 2.1 | -1.1 | n/a | 7.1 | n/a | 4.1 |
| **2000** | 7.3 | 4.4 | 5.4 | 4.2 | 4.5 | 4.5 | n/a | 2.9 | 5.3 | 4.2 |
| **2005** | 5.8 | 3.9 | 6.4 | 4.3 | 2.3 | 4.4 | 4.2 | 4.2 | 5.4 | 4.0 |
| **2010** | 3.5 | 0.8 | 0.4 | -2.3 | -4.9 | 2.9 | 2.5 | -1.1 | 1.0 | 1.2 |
| **2013*** | 0.4 | 2.1 | 0.9 | -0.9 | -3.9 | 2.9 | 3.5 | 3.5 | 2.5 | -1.0 |
| | | | | | | | | | | |
| **CAGR** | | | | | | | | | | |
| **1990-1999**** | 0.7 | n/a | -5.0 | 2.4 | 2.1 | -0.1 | n/a | -2.1 | n/a | 4.2 |
| **2000-2013** | 4.5 | 2.9 | 3.4 | 1.6 | 0.1 | 2.4 | 3.1 | 3.7 | 3.0 | 1.8 |

Note: *2013 is estimate for some countries; ** Data starts from 1992 for Croatia, FYRO Macedonia & Slovenia

Source: IMF World Economic Outlook Database, October 2014

**Figure 1. Map of the Balkans**



# I. Economic Overview

Having been in an economic decline in the 1990's, Balkan countries – with the exception of Greece – grew modestly over the period 2000 to 2013 on an annual average basis. As Table 2 on the preceding page shows, GDP increases ranged from 4.5% (for Albania) to 1.6% (for Croatia)[1]. Growth was driven by economic activity prior to the 2008-2009 financial crises, with strong domestic demand fuelled by credit and wage growth. Transition from socialist centrally planned economy to free-market capitalism certainly encouraged growth in the region. The tourism industry has contributed positively towards Balkan economies and, although still small, continues to gain a rising share of GDP. Foreign investment is also picking up. Recent data indicate that these countries have been slow to recover following the 2009 dip. The fastest increase recorded by a Balkan country, and in this case Romania, was just 3.5% in 2013. The International Monetary Fund (IMF) estimates growth in most Balkan countries will climb back to pre-crisis levels over the next five years.

The only outlier to the above is Greece – the largest economy in the region. The country merely realized growth over the fourteen year period, owing largely to its sovereign debt crisis that took place in the latter part of these years. It is estimated that Greece's 2009 government deficit reached 15% of GDP and public debt at over 125% of GDP, making it the largest deficit (as a percentage of GDP) among the EU member nations. However, a combination of financial bailouts and harsh austerity measures enabled Greece to achieve a primary government budget surplus in 2013 and by the second quarter of 2014 the country returned to growth following six years of economic decline.

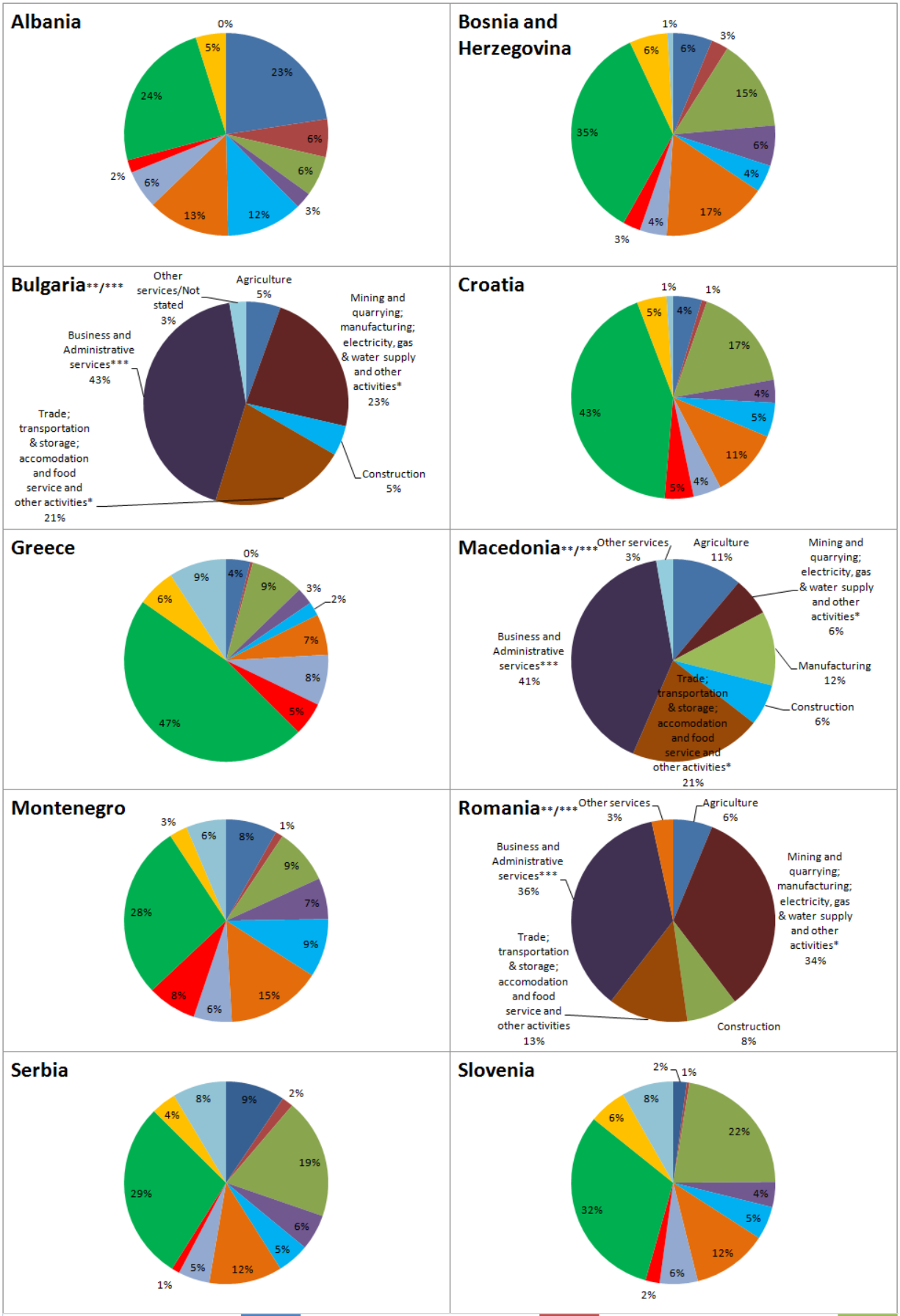
**Key Sectors**

A breakdown by sector shows that all countries share one common trend; the services sector accounts for the lion's share of GDP. In 2013, Greece had the highest share of 80.5%, while FYRO Macedonia had the lowest at 53.7%[2]. Within this, Business and Administrative services accounted for at least a quarter of GDP in all countries. Again, Greece boasted the largest share with 47.3%. The only country in which agriculture remained a relatively high percentage of GDP was Albania, representing 23% in 2013[3]. For most other countries, this sector accounted for less than 10% of national income. The main agricultural products in Albania are tobacco, figs, olives, wheat, maize, potatoes, vegetables, fruits, meat and dairy products.

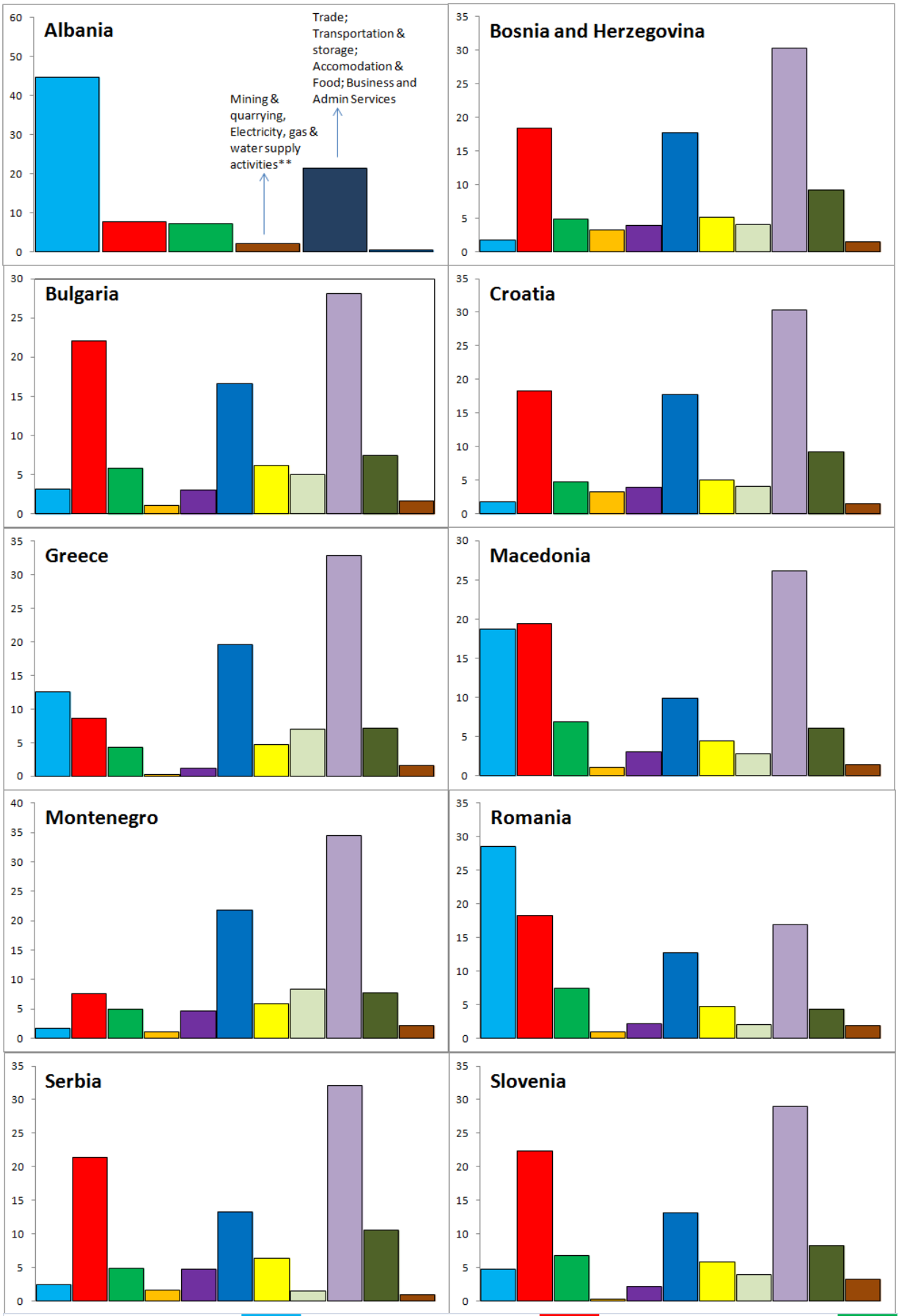
The manufacturing sector took a severe beating during the 2008-2009 global economic crisis, particularly metal manufacturers as global demand contracted and prices collapsed. This also drew related mining industries in its wake. Although both the manufacturing and mining and quarrying sectors combined account for no more than 25% for any particular country, the manufacturing sector represents a larger proportion of GDP than the mining and quarrying sector. In the case of Bosnia and Herzegovina, the share of manufacturing was five times the size of the mining and quarrying sector in 2013. The only other sub-sector of significance is wholesale and retail trade, which accounted for between 6% (for Greece) and 17% for (Bosnia and Herzegovina).

In line with strong growth in the services industry over the past ten years or so, the number of people employed in this sector has increased accordingly. In 2013, people employed in the Business and Administrative services sub-sector alone constituted for around a third of the total labour workforce for most countries.

[1] IMF World Economic Outlook October 2014
[2] CIA World Factbook 2013
[3] Institute of Statistics (INSTAT)




Notes: *except Croatia 2012, **breakdown not available for Bulgaria, Macedonia and Romania, ***Education included in Business and Admin. Category
Business and Administrative services include: Information and communication; Financial and Insurance activities; Professional, scientific and technical activities; Real Estate; Administrative and support services; Public administration and defence
Source: Institute of Statistics (INSTAT), Institute for Statistics of FB&H, National Statistical Institute of Bulgaria, Croatian Bureau of Statistics, National Statistical Service of Greece, Republic of Macedonia State Statistical Office, Statistical Office of Montenegro (MONSTAT), National Institute of Statistics, Statistical Office of the Rep. Of Serbia, Statistical Office of the Rep. Of Slovenia




Notes: *except Romania 2011, **breakdown not available, ***Education included

Business and Administrative services include: Information and communication; Financial and Insurance activities; Professional, scientific and technical activities; Real Estate; Administrative and support services; Public administration and defence

Source: Institute of Statistics (INSTAT), Institute for Statistics of FB&H, National Statistical Institute of Bulgaria, Croatian Bureau of Statistics, National Statistical Service of Greece, Republic of Macedonia State Statistical Office, Statistical Office of Montenegro (MONSTAT), National Institute of Statistics, Statistical Office of the Rep. Of Serbia, Statistical Office of the Rep. Of Slovenia

Other major sector employers were manufacturing (around 20%, except for Montenegro, Albania and Greece whose percentage shares were lower), wholesale and retail trade (between 9.9% for FYRO Macedonia and 21.8% for Montenegro) and education (between 4.3% for Romania and 10.6% for Serbia). The percentage of people employed in the agriculture sector was only significant in Albania (45%), Romania (28.6%) and FYRO Macedonia (18.7%). Employment in the mining and quarrying sub-sector represented just 3.2% at best (for Bosnia and Herzegovina).

Employment is relatively low among women and the young, strikingly so in Bosnia and Herzegovina and Serbia. This is in part due to skill gaps. In some countries, failure to tackle the legacy of self-management and so-called social ownership has contributed to labour market rigidity and de facto protection for insiders. These problems have in turn been compounded by the region's heavy reliance on remittances, which tend to raise reservation wages above what productivity levels can sustain[5].

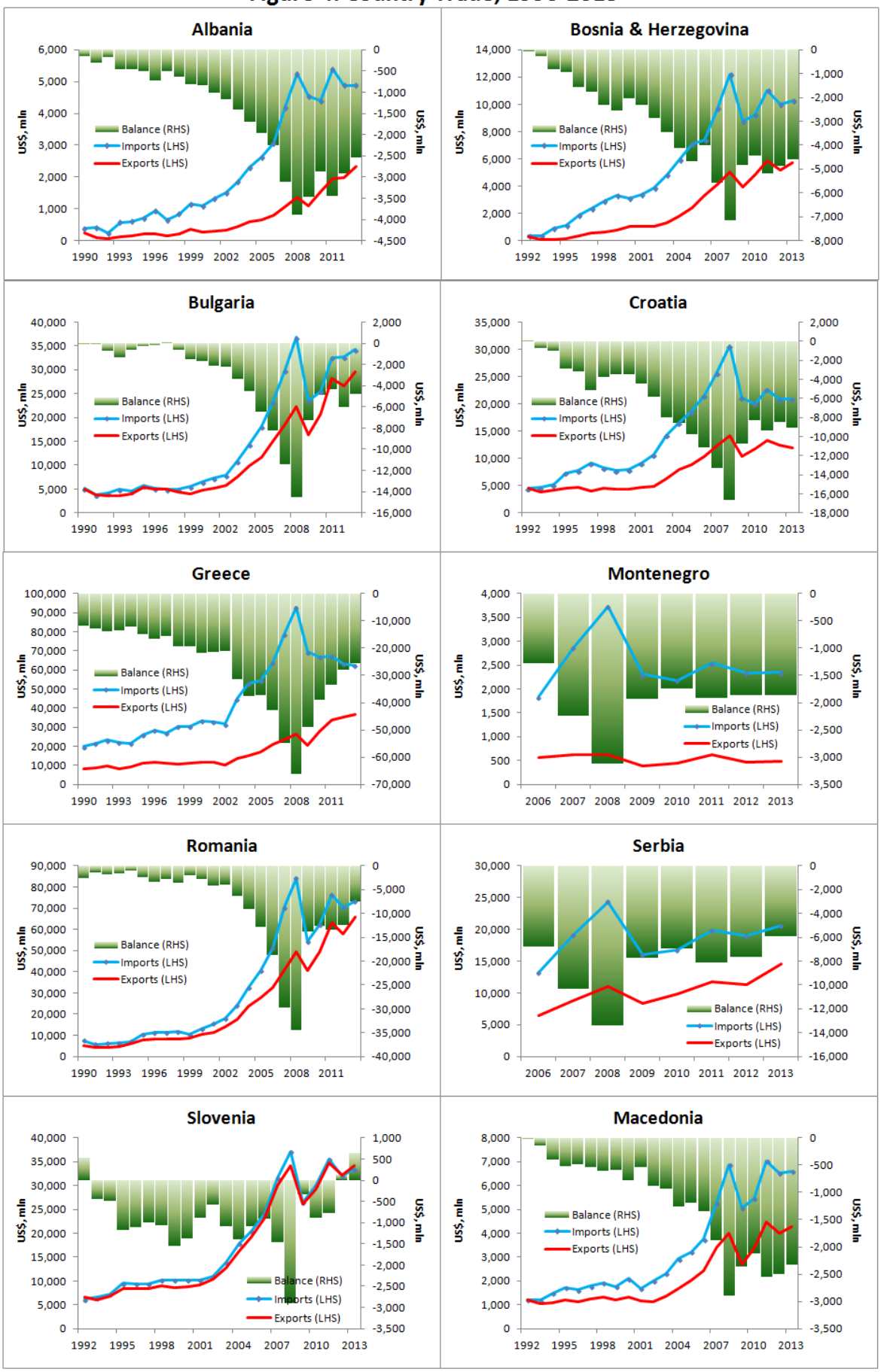
**Trade**

With the exception of Bosnia and Herzegovina and Serbia, the rest of the Balkan countries were members of the World Trade Organization, as of 26 Jun 2014. Over the last two decades, Balkan countries have largely been characterised by growing trade deficits, driven by significant amounts of bank lending, consumption and foreign direct investment. This trend was most acute until 2008/2009, when both exports and imports sagged and industrial production slumped due to a sharp deterioration in the global economy. This bought with it a shortage in trade finance. Although trade balances remain in deficit, these have more than halved for most countries, and have even been reduced by close to a third in countries such as Greece and Bulgaria. In 2013, Bulgaria's trade deficit was estimated at US$4.794 billion compared with US$14.546 billion in 2008. The reduction mainly reflected a sharp pickup in exports, particularly in 2011 when they increased by double-digits. Investor confidence had also strengthened by the end of 2013 as leading macroeconomic indicators suggested economies such as Greece's freefall had been arrested.

Trade to GDP for the period 2011-2013 was the highest in Slovenia at 140.7, followed by Bulgaria (136.3) and FYRO Macedonia (126.8), indicating that international trade was playing an important role in these countries. In 2013, Romania ranked 51$^{st}$ in world exports and 44$^{th}$ in imports – the highest among Balkan countries[4]. Conversely, Montenegro was ranked the lowest at 166$^{th}$ and 150$^{th}$ positions, respectively. In merchandise trade, manufactures are the leading generators of both export and import revenue (with Slovenia representing the highest share of 81.1% for exports and Romania for imports with 76.9%). The European Union (28) was the main destination for trade in 2013, accounting for over 60% in most cases.

[4] World Trade Organisation Statistical Database September 2014
[5] IMF, The Western Balkans: 15 years of Economic Transition

## Figure 4. Country Trade, 1990-2013*




Notes: Except Montenegro and Serbia 2006.

Source: World Trade Organisation Statistical Database

### Government Role

The late eighties and early nineties saw the collapse of the formers Easters Block, the violent break-up of the former Yugoslavia and the beginning of the transition from communism in the region. In countries such as Albania and Bosnia and Herzegovina, the transition proved challenging as successive governments tried to deal with high unemployment, widespread corruption, dilapidated infrastructure, powerful organised crime networks and combative political opponents. Over the years, a number of Balkan countries have received financial assistance from the IMF and the EU in the form of loans largely to help improve infrastructure including road and rail network, a long standing barrier to sustained economic growth. For example, in October 2012, the IMF approved a two-year stand-by arrangement of 405.3 million Euros to Bosnia.

Although these countries have made progress in their democratic developments, deficiencies remain. Their ability to enhance structural reform has been particularly disappointing, owing to a combination of reform fatigue, resistance from vested interest, difficult politics that have constrained reform efforts and delayed membership in the European Union. Balkan countries thus still lag well behind the New Member States of the EU in terms of economic transformation and income levels. Slovenia however has fared better. Historical ties to Western Europe and a stable democracy have assisted in its transformation to a modern state. Slovenia acceded to both NATO and the EU in the spring of 2004 and joined the Euro zone in 2007.

By comparison, Greece has experienced a series of major reforms in the last five years or so with a view to rebalance the economy (following the 2008/09 downturn) by restoring the country's competitiveness and ensuring that growth prospects are based on sustainable factors rather than on a consumption pattern that is fuelled by external borrowing. Some notable examples of reform include the complete overhaul of labour market institutions, the reform of the pension system and the drastic reduction in healthcare spending. The progress that Greece has made both on the structural and fiscal front is well acknowledged by international organisations. Between 2008 and 2013, Greece improved by five positions in the OECD "Product Market Regulation" indicator while in 2013 the country was ranked first in the "adjustment progress indicator" by the Lisbon Council & Berenberg Bank[6].

# II. Metals Sector

### Historical Development

Mining activities in the Balkans date back to at least the 5th century BC. By the time of the Roman Empire, there is evidence that many deposits mined today were already being exploited and almost all known lead and zinc deposits were being mined by the 13th and 14th century[7]. By the early 1930s mineral deposits in the region were well-defined, with increasing levels of exploitation. The major base metals mined have included aluminum, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel and zinc. In the period up until the early 1990s, minerals processing and downstream exploitation established the region as a major European source of copper, lead and zinc. However, following the disintegration of the former Eastern Block in the 1990s, economic conditions in the region declined sharply, and with it industrial output. This bought a widespread shutdown of mining operations, with many still abandoned or privatized.

[6] Greek National Reforms Programme April 2014 Report
[7] UNEP, Mining and Environment in the Western Balkans

**Mining Regulations and Taxation**

*This is detailed below for countries that information is common and widely available*.

The mining sector in **Albania** is regulated by Law No. 10304 for the Mining sector in the Republic of Albania, dated 15 July 2010, which entered into force in August 2010 and abrogated the Mining Law No.7796, dated back 17th February 1994. Specifically this law gives the classification of minerals, types of permits and the terms and conditions that apply to each type of mineral permit. The Mining Sector Law does not restrict foreigners on acquiring mining rights.

Exploration and mining activities are not subject to any special rules in relation to taxation matters, except payment of the mining rent (royalty tax) to the Albanian State[8]. As per amendments to the Law on National Taxes on 28th July 2008, the royalty tax is fixed as a percentage over the sale price of a mineral. In the case of metallic minerals the tax rate varies between 4-10% (depending on the specific metal). Mining activity is also subject to taxation in pursuance with the Albanian tax legislation: applicable VAT at 20% and a flat rate of 15% for corporate tax. Up to 1 January 2012, more than 700 mining permits were issued by the Ministry of Economy, Trade and Energy. Out of these, over 620 exploitation permits were given; 4 to copper producers in three districts and 32 to iron-nickel producers in six districts[9].

The main legislation for the **Bulgarian** mining industry is the Underground Resources Act adopted in March 1999. The mining industry is administered by the Minister of Economy and Energy, the centralised body that implements State policy for the industry as determined by the Council of Ministers. Mineral resources are divided into 7 groups. Mining permits for prospecting and/or researching are issued by these authorities. Candidates for these permits could be a local or foreign person who is registered as a trader in accordance with the legislation of the place of business of the trader. The permit holder is required to pay an administrative fee for issuing a permit and an annual area fee which is charged per square kilometre occupied. There are some clauses which allow reduction of the concession fee of up to 50% or exemption from the obligation to pay for up to five years.

Mining companies are subject to the general corporate tax regime, currently a flat 10% rate. Royalties are paid to the State, regardless of the level of profit attained from the activities. The amount is either: based on a specific formula, taking into account the type, group and value of underground resources; or a fixed fee per tonnes or cubic metre. Half of the royalty is paid to the local municipalities.

The core legal mining provision in **Romania** is Law No. 85/2003 (Mining Law) which replaced the law adopted in 1998. The National Agency for Minerals Resources is the main institution with supervisory and regulatory authority in the mining industry. Foreign investors in Romania enjoy equal legal treatment to that which is applied to Romanian investors. However, foreign companies that are awarded a permit must incorporate a subsidiary in Romania within 90 days from the date the permit enters into force. An exploration licence is granted for a period of maximum five years with a renewal right of maximum three years.

Mining in Romania is subject to an annual tax for reconnaissance, exploration and mining and mineral resources, which are updated every year in accordance with the inflation rate. Currently, for reconnaissance the tax is RON 320 per square kilometre; for exploration RON 1,280 per square kilometre (doubled after the first two years and multiplied by five after four years) and for mining RON 32,000 per square kilometre. In addition to the above, the candidate is subject to the State taxes provided by the Romanian Fiscal Code, for example, profits tax is 16%. Royalty on the other hand is calculated at 5% for non-ferrous metals and 6% for precious metals.

[8] International Comparative Legal Guides (ICLG), Albania Mining Law 2015

[9] National Agency for Natural Resources website

The prevailing mining laws in **Greece** date back to 1973 with several revisions since. The latest was in February 2012, regarding the royalties payable on mining leases to the government. Specifically, royalties were increased in line with international practices and are calculated on a scale as follows: 12% on the ore sale ex. Works; 8% on FOB price; 4% on FOB price following mechanical preparation (crushing, etc); 2% on concentrates; and 1.5% on the final product. Corporate tax was increased to 26% in 2014 from 20% in 2013. VAT tax varies from 6.5% to 23% depending on which category a good falls into. Mining activity is controlled by The Mining Code (Legislative Decree 210/1973 as amended by Law 274/1976) and associated secondary laws. Minerals are classified into two categories namely quarry mineral and ores.

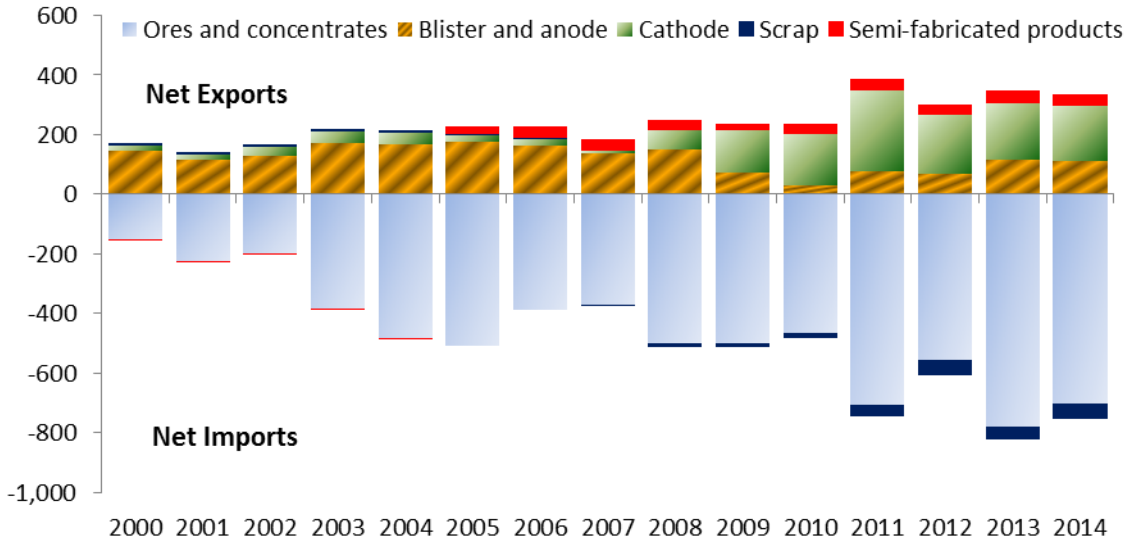
The Mining Law in **Croatia** was adopted in 1991 and has been in effect since 1995. The law established that mineral wealth, comprised of all organic and inorganic mineral raw materials, is the property of the Republic of Croatia. Exploration is usually granted to a legal person with a seat in the Republic of Croatia that is registered for carrying out such activity and to a natural person that has a craft trade for carrying out exploration in the country. For exploration of mineral raw materials compensation is paid at the rate of 2.5% of the income earned from retailing the product. This is paid to the municipality or town in the territory where the exploration is undertaken[11].

# III. Copper in the Balkan Region

**Trade**

The main emphasis here will be on Bulgaria and to some extent FYRO Macedonia, Albania and Serbia since trade flows are most prominent in these countries. Bulgaria has successively been a net importer of copper since the year 2001 and this position has grown over recent years. In 2013, Bulgaria was a net importer by around 473,000 tonnes, representing almost a six-fold increase since 2001, when it switched from a net-exporter (see Figure 10 below). Copper imports have mostly been in the form of ores and concentrates as local mine production has been insufficient to serve smelting capacity at Pirdop, and a small proportion from copper scrap. Exports have comprised a combination of ores and concentrates, blister and anode, cathodes (refined copper) and semi-fabricated products.

**Figure 10. Bulgaria Copper Net Trade 2000-2014***




(*) Preliminary data

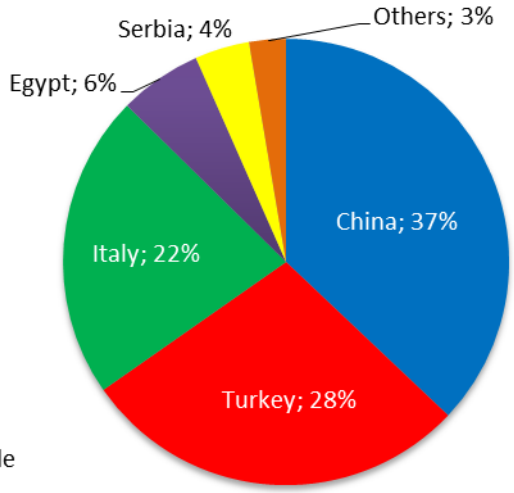
Source:

The top five concentrate import origins in 2013 were Spain (63%), Georgia (12%), Turkey (8%), FYRO Macedonia and Australia both constituting 5% each, with the remainder being shipped from Portugal, Tanzania, South Africa, Russia among others. Bulgarian imports of ores and concentrates totalled over 1 million tonnes in 2013 – the highest on record – representing a 33% increase on 2012. Higher volumes were largely seen from the aforementioned top five countries; Spain (+37%), Turkey (+357% or 60,000 tonnes), FYRO Macedonia (+14%), Georgia (+5%) and Australia which although did not export in 2012 shipped 45,545 tonnes in 2013.Bulgaria's top five concentrate export destinations in 2013 were China (48%), Namibia (46%), Oman (4%), Switzerland (1%) and Singapore (0.3%). The remaining 1% of concentrates was shipped to Poland, Philippines, Austria, Thailand and Turkey. On aggregate, exports were up 12% year-on-year at 228,611 tonnes in 2013. The gain reflected an almost 80% (or 48,721 tonne) increase to China, which helped offset the near 15% (or 18,021 tonnes) decline in exports to Namibia. Similar to previous years, China's appetite for ores and concentrates increased massively in 2013 in response to strong demand from smelters and refineries.

Bulgaria exports far more cathode than it imports. For example, in 2013 the country exported 199,697 tonnes of cathode compared with imports of just 12,225 tonnes. The major destinations for Bulgarian cathode exports were China (37%), Turkey (28%), Italy (22%), Egypt (6%) and Serbia (4%). The

remaining 3% of cathode was exported to Malaysia, Greece and Romania (see Figure 11 below). In 2013, Bulgaria was the 14th largest exporter of cathode and accounted for just 2% of world refined

**Figure 11. Bulgaria Cathode Exports, 2013**




Source: UN Comtrade

exports (see Table 8 below). The respective figures for 2014 were 11th and 2.7%.

A similar situation is evident for semi-fabricated products, where exports have far exceeded imports, a trend evident since 2004. In 2013, exports totaled 52,200 tonnes compared with imports of just 9,800 tonnes. Around 90% of exports have been accounted for by copper semi-fabricated products while the rest by alloy based semi-fabricated products.

A handful of other Balkan countries were also net-exporters of copper in 2013. Among them, FYRO Macedonia was the largest, recording net-exports of 55,870 tonnes. FYRO Macedonia has predominantly been a net-exporter but there have been two years since the turn of the millennium (2004 and 2008) that the country turned into, albeit a very small, net-importer. On balance, most of the country's copper trade is export-based, the bulk of which is represented by ores and concentrates. Latest data shows exports of ores and concentrates totaled 42,034 tonnes in 2014, of which almost the entire amount, similar to previous years, was shipped to Bulgaria. A very small volume went to Serbia.

Albania has consistently been a net-exporter of copper since the year 2000, with the vast majority of trade export-based comprising of ores and concentrates. In 2013, the country was net-exporter of all copper products by around 43,000 tonnes, representing an increase of 40,000 tonnes on the lowest level recorded in 2001. In recent years, most if not all ores and concentrates have been shipped to China. Latest UN Comtrade data, there was a sharp drop in Albanian exports of ores and concentrates last year. Exports plummeted to just 206 tonnes from 38,311 tonnes in 2013.

Serbia has been a net exporter of copper since 2010 prior to which it was a successive net importer. The main reasons behind this switch were because the country stopped importing copper ores and concentrates and at the same time started reducing cathode imports. Instead Serbia started increasing cathode and scrap exports. Serbia has been a net exporter of copper by over 30,000 tonnes since 2012. Semi-fabricated exports meanwhile have been falling in recent years, coinciding with a gradual

increase in imports. Serbia's net-exports of copper and copper alloy semi-fabricated products have slipped from a peak of 38,400 tonnes in 2010 to 9,200 tonnes in 2013.

**Table 8. Top 20 Exporters of Refined Copper, 2013 ('000 tonnes)**

| Rank | Country | Quantity | % Share of World Total |
|---|---|---|---|
| **1** | Chile | 2586.0 | 31.5 |
| **2** | Japan | 572.1 | 6.4 |
| **3** | Australia | 403.7 | 6.2 |
| **4** | Kazakhstan | 371.0 | 4.6 |
| **5** | Poland | 343.6 | 3.9 |
| **6** | China | 293.4 | 3.6 |
| **7** | Peru | 284.4 | 3.4 |
| **8** | Malaysia | 266.8 | 3.4 |
| **9** | India | 237.1 | 3.3 |
| **10** | Belgium | 230.2 | 2.6 |
| **11** | Germany | 221.4 | 2.5 |
| **12** | Russian Fed. | 210.6 | 2.4 |
| **13** | Netherlands | 208.4 | 2.2 |
| **14** | Bulgaria | 199.7 | 2.0 |
| **15** | Korean Rep. | 179.9 | 2.0 |
| **16** | Canada | 170.7 | 1.6 |
| **17** | Spain | 113.6 | 1.4 |
| **18** | United States | 113.4 | 1.4 |
| **19** | Austria | 99.6 | 1.3 |
| **20** | Sweden | 91.3 | 1.2 |

**Table 9. Top 20 Exporters of Copper Ores and Concentrate, 2013 ('000 tonnes)**

| Rank | Country | Quantity | % Share of World Total |
|---|---|---|---|
| **1** | Chile | 8405.9 | 32.8 |
| **2** | Peru | 3811.9 | 7.3 |
| **3** | Australia | 2145.0 | 5.1 |
| **4** | Indonesia | 1453.7 | 4.7 |
| **5** | Canada | 1415.8 | 4.4 |
| **6** | United States | 1159.9 | 3.7 |
| **7** | Brazil | 854.3 | 3.6 |
| **8** | Mongolia | 802.4 | 3.4 |
| **9** | Spain | 726.1 | 3.0 |
| **10** | Mexico | 683.5 | 2.9 |
| **11** | Philippines | 445.8 | 2.8 |
| **12** | Turkey | 428.2 | 2.7 |
| **13** | PNG | 394.6 | 2.6 |
| **14** | Argentina | 394.6 | 2.5 |
| **15** | Portugal | 328.3 | 2.3 |
| **16** | South Africa | 263.0 | 2.2 |
| **17** | Kazakhstan | 255.8 | 1.4 |
| **18** | Bulgaria | 231.4 | 1.4 |
| **19** | Armenia | 173.2 | 1.3 |
| **20** | Mauritania | 168.8 | 1.2 |

Source: ICSG

## COPPER INDUSTRY

Before 1989/1990 the Balkans countries included in this study (with the exception of Greece) were part of the so called Eastern Bloc and were under the umbrella of the Soviet Union or under the ruling of communist regimes (Albania and Yugoslavia). At that time mining companies were state owned and due to the isolation of these countries, access to new mining and exploration technologies from the western world was difficult and productivity (controlled by the regime) was the main target regardless efficiency or profitability. Due to lack of investment the metals' industry turned obsolete and environmental unfriendly and the mining industry suffered from declining ores grades at ageing mines and deterioration of mining equipment..

After the collapse of the Soviet Union the Eastern Bloc countries started to turn into democratic regimes with access to free international market. The obsolete copper industry had to modernize to be competitive in international markets and several copper mines and plants closures occurred in this transition period. While the countries opened to privatization and foreign investment, exploration activity started to increased. Because exploitation of mineral resources in the Balkans has been stagnant during the Eastern Block time there is now opportunity for growth in the region.

In the last decade new exploration licenses were tendered to foreign companies, companies were privatized, some closed mines were modernized and restarted production and a few mining projects are currently being evaluated by foreign companies. On the metals side old copper smelters and refineries shut down and the two that remained in operation in Bulgaria and Serbia were modernized by international standards.

## COPPER RESOURCES

ICSG does not collect data on copper resources and rely on the research undertaken by the U.S. Geological Survey (USGS) to assess world copper resources.

In 2013, the USGS in collaboration with European geologists undertook a study to assess resources in porphyry copper deposits in Europe, exclusive of Scandinavia and Russia and including the Balkans region. We are presenting here a summary of the abstract. For more information please contact Mrs Jane Hammarstrom at the USGS (jhammars@usgs.gov) and the full study can be downloaded from USGS website at the following link:

http://pubs.usgs.gov/sir/2010/5090/k/sir2010-5090k_text.pdf

Porphyry copper deposits in Europe are Paleozoic and Late Cretaceous to Miocene in age. A number of the 31 known Phanerozoic deposits contain more than 1 million metric tons of contained copper, including the Majdanpek deposit, Serbia; Assarel, Bulgaria; Skouries, Greece; and Rosia Poeni, Romania. Five geographic areas were delineated as permissive tracts for post-Paleozoic porphyry copper deposits. Two additional tracts were delineated to show the extent of permissive igneous rocks associated with porphyry copper mineralization related to the Paleozoic Caledonian and Variscan orogenies. The tracts are based on mapped and inferred subsurface distributions of igneous rocks of specific age ranges that define areas where the occurrence of porphyry copper deposits within 1 kilometer of the Earth's surface is possible.

Probabilistic estimates of undiscovered porphyry copper deposits were made for four Phanerozoic permissive tracts; the other tracts are discussed qualitatively. Assessment participants estimated numbers of undiscovered deposits at different levels of confidence for the four tracts. These estimates were then combined with grade and tonnage models using Monte Carlo simulation to generate

probabilistic estimates of amounts of in-place undiscovered resources. Additional resources that may be present in extensions of known deposits were not evaluated.

This assessment estimated a mean of 14 undiscovered porphyry copper deposits within the four permissive tracts for which estimates were made. On the basis of global grade and tonnage models, mean (arithmetic) estimated resources that could be associated with undiscovered deposits are about 46 million metric tons of copper and about 2,600 metric tons of gold, as well as byproduct molybdenum and silver. Reliable reported identified resources for the 27 deposits in the assessed areas total about 44 million metric tons of copper and about 2,300 metric tons of gold. Exploration for gold-rich porphyry systems is ongoing in some parts of historical copper mining districts in central Europe and in northwesternmost (European) Turkey. Political and social conflicts, environmental concerns associated with historical mining, and the global economic situation have had negative effects on exploration, development, and mining in Europe for many years.

## MINE PRODUCTION

Based in the data available in ICSG database (starting 1970) there hasn't been in the last thirty years any copper mining in Bosnia and Herzegovina, Croatia, Kosovo, Montenegro nor Slovenia. Based in ICSG Directory there isn't either any copper mining projects planned for these countries in the near term future. Therefore copper has been mined only in Albania, Bulgaria, FYRO Macedonia, Romania and Serbia. There has been some copper mine production in Greece in the seventies early eighties with the sole country mine closing in 1982.

Chart 1

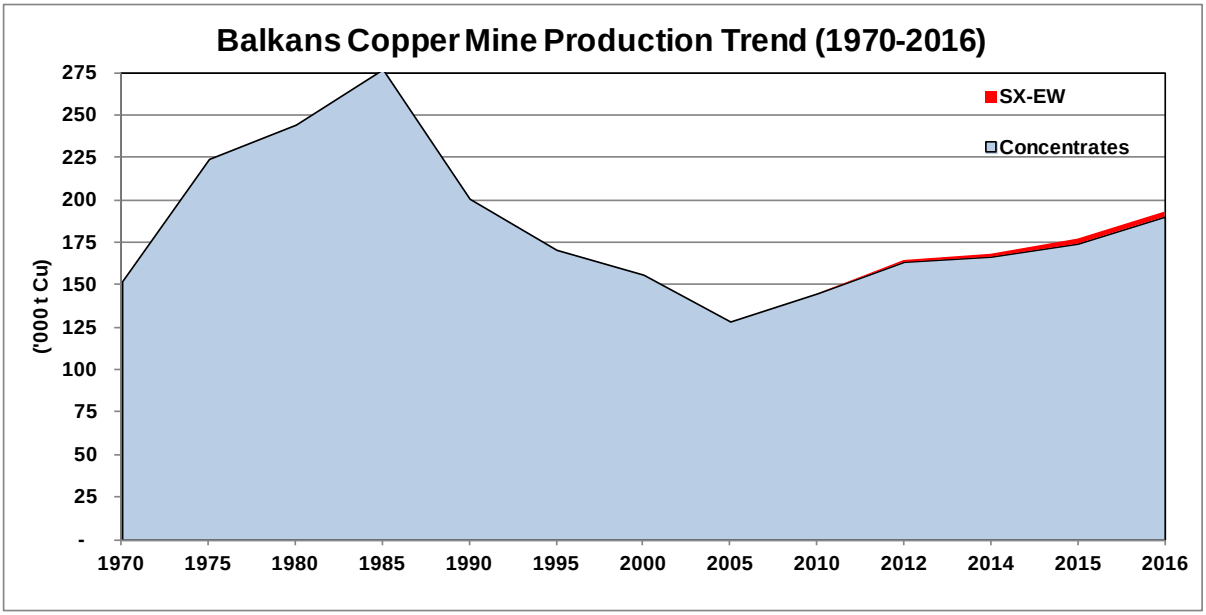



Chart 1 above shows the trend in the Balkans copper mine production since 1970. Production in the early seventies was around 150kt peaking to 275kt around mid eighties. Production then started to sharply decline in early nineties impacted by the collapse of the former eastern bloc regimes, uncompetitiveness of the state owned copper mines and the war in former Yugoslavia countries. In the late nineties/early 2000 improved economic performance and political stability of the Balkans states attracted the attention of foreign investors. By the second half of last decade production started to

recover mainly due to the modernization and privatization of several copper mines. In 2014, production is estimated to have been around 170kt as compared to the bottom level of 129kt reached in 2005. Currently the Balkans output represents less than 1% of the world copper mine production comparing with a share of around 3.5% in 1980.

Copper mine production in the Balkans has been almost all in the form of concentrates with only a small production of SX-EW copper in FYRO Macedonia that started in 2011. In 2015 and 2016, mine production is expected to continue increasing mainly due to the optimization of Serbian mine production capacity and the startup of a new mine in Romania. Total mine production in 2016 is foreseen at around 195kt Cu representing an increase of 15% as compared to 2014 production.

In terms of copper mine production capacity an increase of 37% (80kt Cu) is expected until 2018 mainly due to the development of new mines in FYRO Macedonia, Romania and Greece. In the future, with the current increase in exploration in the Balkans region there is significant scope for further rise in copper mine production.

Table 1 below list the Balkans countries that are currently, or have been mining copper. Production is detailed by concentrate and SX-EW (solvent extraction-electrowining)

Table 1 – Copper Mine Production by Country thousand tons copper

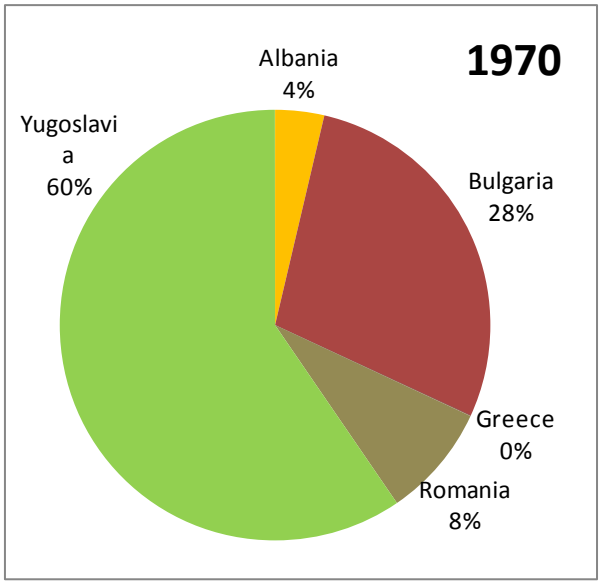
| Country | Mine Productio | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 | 2012 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albania | Concentrates | 6 | 9 | 13 | 12 | 13 | 4 | - | 2 | 3 | 6 | 6 | 6 | 7 |
| Albania | SX-EW | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Albania | Mine Total | 6 | 9 | 13 | 12 | 13 | 4 | - | 2 | 3 | 6 | 6 | 6 | 7 |
| Bulgaria | Concentrates | 43 | 55 | 62 | 78 | 33 | 77 | 93 | 95 | 105 | 108 | 110 | 110 | 110 |
| Bulgaria | SX-EW | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Bulgaria | Mine Total | 43 | 55 | 62 | 78 | 33 | 77 | 93 | 95 | 105 | 108 | 110 | 110 | 110 |
| Greece | Concentrates | - | 0.4 | 0.1 | - | - | - | - | - | - | - | - | - | - |
| Greece | SX-EW | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Greece | Mine Total | - | 0.4 | 0.1 | - | - | - | - | - | - | - | - | - | - |
| Macedonia | Concentrates | - | - | - | - | - | 6 | 8 | 3 | 8 | 9 | 8 | 9 | 9 |
| Macedonia | SX-EW | - | - | - | - | - | - | - | - | - | 1 | 2 | 3 | 3 |
| Macedonia | Mine Total | - | - | - | - | - | 6 | 8 | 3 | 8 | 10 | 10 | 12 | 12 |
| Romania | Concentrates | 13 | 45 | 55 | 45 | 32 | 24 | 16 | 16 | 5 | 7 | 7 | 7 | 20 |
| Romania | SX-EW | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Romania | Mine Total | 13 | 45 | 55 | 45 | 32 | 24 | 16 | 16 | 5 | 7 | 7 | 7 | 20 |
| Serbia | Concentrates | - | - | - | - | - | 60 | 39 | 13 | 24 | 34 | 36 | 43 | 45 |
| Serbia | SX-EW | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Serbia | Mine Total | - | - | - | - | - | 60 | 39 | 13 | 24 | 34 | 36 | 43 | 45 |
| Yugoslavia 1) | Concentrates | 91 | 115 | 115 | 143 | 123 | - | - | - | - | - | - | - | - |
| Yugoslavia 1) | SX-EW | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Yugoslavia 1) | Mine Total | 91 | 115 | 115 | 143 | 123 | - | - | - | - | - | - | - | - |
| **Balkans** | **Concentrates** | **152** | **225** | **245** | **278** | **201** | **171** | **156** | **129** | **145** | **164** | **167** | **175** | **191** |
| **Balkans** | **SX-EW** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **2** | **3** | **3** |
| **Balkans** | **Mine Total** | **152** | **225** | **245** | **278** | **201** | **171** | **156** | **129** | **145** | **165** | **169** | **178** | **194** |
| **%in World mine production** | | **2.6%** | **3.3%** | **3.4%** | **3.3%** | **2.2%** | **1.7%** | **1.2%** | **0.9%** | **0.9%** | **1.0%** | **0.9%** | **0.9%** | **0.9%** |

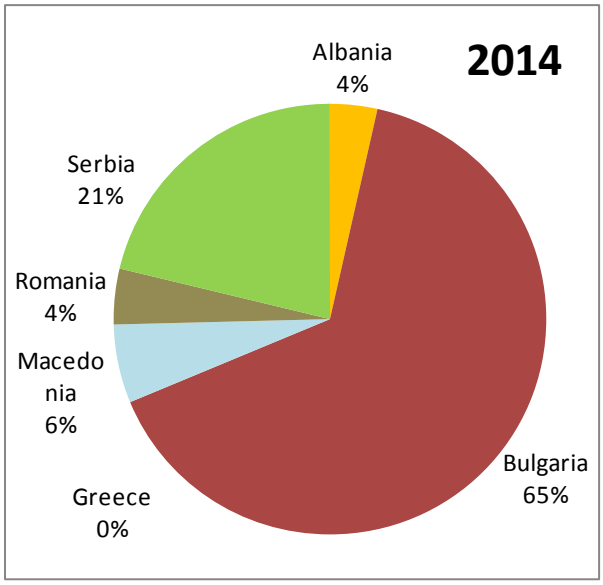
1) Former Federal Republic of Yugoslavia until 1991

In the seventies and eighties the former Federal Republic of Yugoslavia (included Bosnia and Herzegovina, Croatia, FYRO Macedonia, Montenegro, Slovenia and Serbia) was the biggest copper mine producer in the Balkans with copper mining occurring only in the Serbian and FYRO Macedonian territories. In the early nineties production was affected not only by the collapse of the regime but also by the war that followed. Production declined sharply in Serbia and Bulgaria became the biggest copper mine producer in the Balkans, currently producing around 110kt copper in concentrates.

Chart 2 A and Chart 2 B on next page show the share of each Balkan country in the total copper mine production, comparing the years 1970 and 2014. The charts highlight the growth in Bulgaria share and the loss of former Yugoslavia countries share.

Chart 2A – Country Mine Production Share 1970 Chart 2B – Country Mine Production Share 2014




In **Bulgaria**, copper mine production peaked in 1985 to almost 85kt Cu in concentrates and then declined in the late nineties/early 2000 due to the transition to market-oriented economies and due also to the planned decline in production at the Medet mine. Through industry privatization and modernization production started to increase again and is currently at a rate of 110ktpy copper in concentrates. There are currently three operating copper mines in the country: Assarel, Ellatzite and Chelopech.

In 1964 Medet Mining and Processing Complex (IOC mine) started copper production. At that time it was considered the largest open pit copper mine in Europe. In 1989 a new deposit in the Medet area was commissioned (Assarel Mining and Processing Complex) and reached full capacity in 1995. The Assarel-Medet company was then privatized in 1999. A large-scale project for modernization and life extension of the Assarel Mine and concentrator was implemented in the period 2014-2007. Currently the Assarel mine produces around 200,000 ktpy concentrates at 25% Cu and is the biggest copper mine in Bulgaria

The second biggest copper mine in the country is Ellatzite operated by Ellatzite-Med. The company was privatized in 1999 and belongs to the Geotchmin Group. The mine (open pit) started in 1981 and has currently a production capacity of around 45ktpy Cu contained in concentrates.

The third copper mine is Chelopech owned by Dundee Precious Metals. This underground mine started production in 1954 and produces complex concentrates with relatively high grades of Arsenic. Before 1990, the Pirdop smelter, located seven kilometres from Chelopech, accepted the sulphide-rich concentrates from the mine and blended them with cupriferous concentrates from the Elatsite and Assarel mines. The high content of arsenic in the Chelopech copper concentrates led to the Bulgarian Government decreeing in 1990 that Chelopech concentrate could no longer be treated in Bulgaria at the Pirdop smelter. In February 1992, the mine was placed on care and maintenance. In 1993, Navan acquired the mine and operations restarted with the concentrate being exported to smelters outside Bulgaria but the company went into bankruptcy in 2002. Chelopech was then acquired by Dundee in

2003. Through a series of improvements and expansion ore treatment capacity increased from half a million in 2004 to two millions in 2014. In 2014 the mine produced 126ktpy copper concentrate at 16% Cu (around 20kt copper contained)

Almost all copper concentrate production is exported to Namibia to the Tsumeb smelter that Dundee Precious Metals acquired in 2010. The smelter is one of only a few in the world which is able to treat arsenic and lead bearing copper concentrates. In 2014 a pyrite concentrate circuit including a new flotation, thickening and filtration installation was commissioned and Chelopech started exporting as well pyrite concentrates to China.

Although exploration activity is being undertaken by Dundee it is not expected that any new mine will start in the near term future nor it is anticipated that any of the above mentioned three mines will expand their production capacity so that for the period 2015-2018 Bulgaria copper mine production levels should be maintained at around current levels.

Additional information on the Bulgarian and other Balkan countries' copper mines can be found in Table 2 (at the end of this section) that lists the closed and operating copper mines as well as the projects for the Balkan countries in the period 1975-2018. Table 2 presents capacity data as well as information on ownership, mine process, type, and status, startup and closure dates, concentrate copper grades and other metals (by-products) produced and is based on ICSG Directory of Copper Mines and Plants.

In **Serbia**, and as previously referred the copper industry was also affected by the war among former Yugoslavia states. Production that was around 140 kt Cu in concentrates in 1985 bottom to 12ktpy in the early years of last decade. Since then production is recovering although at a slow pace. All copper mine is produced by RTB Bor. After attempts to sell RTB Bor to Romania's Cuprom or Austria's A-Tec failed, the government opted to fund the regeneration of the company itself and RTB Bor remains a state company.

RTB Bor started copper production in 1904 at the Jama mine. Currently the company operates four mines: the Bor complex comprises two open pit mines (Veliki Krivelj started in 1983 and Cerovo in 1994), one underground mine (Jama), two flotation plants (in Krivelj and Bor); the Majdanpek complex that include the Majdanpek open pit mine and concentrator that started operations in 1961.

In 2014 Serbia copper mine production was 36kt copper in concentrates well below its production capacity. RTB Bor is modernizing and expanding its mines to increase gradually total production of all its mines to 400ktpy of concentrates (around 80ktpy Cu) by 2021, to meet the company's new smelter requirements (see smelter section). Production in 2015 is expected at 43kt Cu in concentrates.

As referred in Avala Resources latest corporate presentation, *"through successful discoveries, Serbia has developed into a top target for exploration in Eastern Europe"*. Indeed there are some copper mine projects currently being evaluated or under exploration in Serbia.

The Timok Project includes seven exploration permits that are held by Rakita d.o.o., a Serbian company in which Freeport-McMoRan and Reservoir Minerals hold 55% and 45% indirect ownership interests respectively. Significant copper-gold high sulphidation and porphyry copper-gold mineralization was found at the Cukaru Peki prospect that is located close to Bor and Majdenpek mines and 5km away from the new RTB Bor smelter. Freeport have exercised their option to sole fund all exploration work to the completion of a bankable feasibility study and is the operator of the Project. Inferred Mineral Resource is estimated at 65.3 Mt @ 2.6% Cu and 1.5 g/t Au, including 6.8 Mt @ 9.6% Cu and 5.9 g/t Au.

Avala Resources (in which Dundee Precious Metals Inc. holds 50.1%) is undertaking exploration work at the Tulare project that includes the Kiseljak and Yellow Creek deposits. Inferred resource is estimated at 523Mt @ 0.24% Cu & 0.23g/t Au.

Reservoir Minerals holds four 100% owned exploration permits: Tilva-Njagra, Čoka, Kupijatra, -Njagra and Čoka Kupijatra. The company through its wholly owned Serbian subsidiary has acquired four exploration permits in Central Serbia covering 277.65 square kilometres of Permian stratigraphy that is highly prospective for sediment-hosted copper-silver mineralization potentially similar to the world-class “Kupferschiefer" deposits in Central Europe (Central Serbia Sediment-Hosted Copper-Silver Exploration Project). The Company is reviewing and compiling the historical data from all the permits, and has initiated a reconnaissance exploration program, including geological mapping, geochemical stream sediment and rock chip sampling.

The KMC project is an early stage copper-gold exploration target in Southern Serbia owned by Euromax Resources. It is an Au-Cu skarn and porphyry system with the potential of becoming a bulk tonnage open pit with possible high grade zones

In **Romania**, the situation is very similar to Bulgaria and Serbia with copper mine production peaking before the end of the regime and then declining due to the closure of non competitive mines. Production declined from around 55kt Cu in concentrates in 1980 to around 7kt Cu in 2014.

There is only one copper mine currently producing in Romania, the Rosia Poieni that is still state owned (Cuprumin S.A.) after the privatization process was cancelled by the government in 2013. This open-pit mine started production in 1983 and produces concentrates with an average grade of 18% Cu. Current annual production capacity is around 10kt copper contained. It is estimated that the mine contains around one billion tons of copper ore grading 0.36% Cu. There is scope for capacity expansion but an intensive modernization plan would be required as the majority of the equipment currently in operation dates from the startup of the mine.

We identified three copper projects in the country that could contribute to the increase in Romanian copper mine production in the future: Vast Resources plc in March 2015 exercised the option to acquire 80% of Mineral Mining SA, the owner of Baita Bihor, a mine that was put on Care and Maintenance in 2003. This poly-metallic mine holds 1.8 million tones copper-silver-zinc-lead-gold-tungsten-molybdenum resource (at 2.19% Cu, 128g/t Ag, 3.46% Zn, 3.07% Pb and 1.41g/t Au) with further upside potential available. The mine will produce concentrates at 26% Cu, 10g/t Au, and 800-1,000 g/t Ag, plus separate Zn and Lead concentrates for a mine life of 15 years. Mine commissioning is planned for 2$^{nd}$ half 2015 and production expected to rise to a sustained rate of 120 ktpy of concentrates (26ktpy Cu contained) in 2016.

In May 2015 Carpathian Gold Inc. entered into an agreement with the Romanian National Agency for Mineral Resources whereby it was granted a 20-year mining license on its Rovina Valley Project. Carpathian will proceed with an update to the Preliminary Economic Assessment (PEA) of 2010 which will outline revised project costs and evaluate scalability options. The PEA envisaged the production of copper concentrates with 18-22% Cu grade and 50-60g/t Au at an average annual copper production of 24kt for the first five years and averaging 22ktpy Cu over the19 year mine life.

On the other side, Reservoir Minerals is undertaking exploration in Romania and has been awarded two exploration licenses in the Banat area of southern Romania. Exploration target is epithermal, porphyry- and skarn-type copper deposits. The company said that both license areas are relatively underexplored by modern exploration techniques and, in particular, drilling.

In **Albania** production was around 13ktpy Cu in concentrates in the eighties and after the end of the communist regime state owned companies encountered difficulties to be competitive in the international markets and were forced to close. By 1997 copper mine production stopped completely. In 2001, Beralb Sh.A, a wholly owned subsidiary of Ekin Maden Ticaret ve San AS (Turkey) restarted the Munelle copper mine and then in 2009 the Lak Roshi mine (ore is treated at the Fushe-Arrez processing plant). Berald is currently the only copper mine producer in Albania and total company production is around 6kt per year. The company is currently developing the Karma mine that starts in 2015 and plans to develop in the future the Qaf Bari, Paluce, Tuçi Lindor, and Fushe Arresi mines.

In terms of copper future mining developments in Albania, in February 2015 Tirex Resources won the government bidding process for the Rehova mining property, a state owned operation that closed in 1990. The mine is estimated to still hold approximately 84% of originally defined historical resources.

Tirex also owns an effective 90% interest in the 344km2 Mirdita Project. The property covers the core of the productive Mirdita VMS base metal district. Tirex reports that it represents an opportunity to explore significant deposits that were previously partially mined or evaluated as well as applying modern exploration techniques toward the discovery of new VMS deposits or extensions of known deposits.

In **FYRO Macedonia**, copper mine production has been relatively stable in the last twenty years at around 10 kt Cu. There is only one copper mine in the country, Bucim, which started production in 1979. This open-pit mine was privatized in 2001 but went into bankruptcy in 2003 and stopped production. It was then acquired by Solway Industries Ltd and restarted production in 2005. Besides producing concentrates the company started producing cathodes through an SX-EW plant in 2011 with an annual production capacity of around 3kt Cu.

Regarding new copper mine projects in the country Kazandol is being developed by Sardic MC with production expected to start in 2016. It's an SX-EW operation with an annual production capacity of 4kt cathode. It will more than double FYRO Macedonia SX-EW production by 2016.

Another project is Ilovitza (owned by Euromax Resouces) with construction expected to start in the 4$^{th}$ quarter of 2016 and initial production in 2017. It is an open-pit mine that will be producing 16ktpy copper in concentrates for a period of 23 years. Probable Mineral Reserve is 209 Mt @ 0.34 g/t Au and 0.20% Cu containing 2.28 Moz Au and 905 M lb Cu. Ilovitza has onward rail transportation directly to the Pirdop smelter in Bulgaria.

Regarding potential copper mining projects in FYRO Macedonia, Reservoir Minerals holds the Dvoriste concession for copper-gold exploration in the belt containing the Bucim mine and Ilovica project, both of which are based on porphyry copper-gold mineralization. The Dvoriste concession was awarded to Reservoir on January 2015 under the terms of an open tender. Reservoir is reviewing and compiling historical exploration data from the Concession area and plans to start fieldwork in the 2$^{nd}$ quarter 2015 after the necessary permissions have been obtained.

There are other announced projects in FYRO Macedonia but the information is very scarce and only available in press reports, not confirmed directly by the companies involved. It is said that Solway is undertaking exploration works at the Kadiica mine. It is also said that exploration is occurring at Zlatica-Plavica and Kratovo.

In **Greece** copper mining is currently inexistent as the Ermionis mine closed in 1982. There is however a new copper mine project being developed by Eldorado Gold Corp. The Skouries project will be mined as an open pit first followed by underground mining with a mine life of 27 years. The

production capacity will be 30ktpy Cu in concentrates from the open pit and 22ktpy Cu from the underground mining and mineral reserves are around 3.6Moz Au and 736Kt Cu. Skouries was expected to start in mid 2013 but was delayed to 2016 and might be further delayed. At the end of February 2015 Eldorado Gold Corp. received a formal notice from Greece's Ministry of Productive Reconstruction, Energy and Environment revoking the approval required to complete final construction of the processing plant. The notice indicates however, that the Ministry may reverse its decision once it completes an internal review process. Eldorado Gold reports that currently the revocation of this approval has no material impact on the construction schedule and various site activities continue.

Additional information on the mines and projects referred in this section can be found in the company's websites listed below

Avala Resources: www.avalaresources.com

Beralb Sh.A: www.beralb.com

Chelopech: www.dundeeprecious.com

Cuprumin: http://cuprumin.ro/

Eldorado Gold: www.eldoradogold.com

Ellatzite-Med: www.geotechmin.com

Euromax Resources: www.euromaxresources.com

RTB Bor: http://rtb.rs/en/

Reservoir Minerals: www.reservoirminerals.com

Tirex Resources: www.tirexresources.com

Solway Investment Group: www.solwaygroup.com

Vast Resource: www.afcrplc.com

Carpathian Gold Inc: www.carpathiangold.com

As referred above, Table 2 on the next page gives additional information on the mines currently operating in the Balkan countries as well as on the new developing or exploration projects.

Table 2: Production Capacity of Copper Mines and Projects in the Balkans thousand tons copper

| Mine | Owner | Process | Status | Type | Start Up | Date of Closure | Other Metals | 1975 | 1980 | 1990 | 2000 | 2010 | 2014 | 2015 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Albania** | | Concentrates | | | | | | 12 | 13 | 16 | | 5 | 6 | 7 | 8 |
| Perlat | Albanian Government | Concentrates | Closed | UG | | 1992 | Zn, Pb | 0.5 | 0.5 | 0.5 | | | | | |
| Rehove Mine | Tirex Resources Ltd | Concentrates | Closed | UG | 1980 | 1990 | Zn, Pb | | 1 | 1 | | | | | |
| Reps Concentrator | Albanian Government | Concentrates | Closed | UG | | 1995 | Zn, Pb | 3 | 3 | 3 | | | | | |
| Reshen | Albanian Government | Concentrates | Closed | UG | | 1995 | Zn, Pb | 0.2 | 0.2 | 0.2 | | | | | |
| Shkoder (Karma/ Palaj) | Albanian Government | Concentrates | Closed | UG | 1982 | 1992 | Zn, Pb | | | 2 | | | | | |
| Fushe-Arrez (Kukes Area) | Beralb ShA | Concentrates | Operating | UG | 1982, 2001 | 1997 | Pb, Zn | 3 | 3 | 5 | | 5 | 6 | 7 | 8 |
| Gjejan | Albanian Government | Concentrates | Closed | UG | | 1995 | | 5 | 5 | 3 | | | | | |
| Golaj Concentrator | Albanian Government | Concentrates | Closed | UG | 1989 | 1997 | Zn, Pb | | | 1 | | | | | |
| Kurbnesh (Mirdita) | Albanian Government | Concentrates | Closed | UG | 1950 | 1995 | | 1 | 1 | 1 | | | | | |
| Mirdita | Tirex Resources Ltd | Concentrates | Feasibility | | | | Au, Zn | | | | | | | | |
| **Bulgaria** | | Concentrates | | | | | | 64 | 68 | 61 | 111 | 108 | 116 | 116 | 116 |
| Medet | Medet Mining Combine | Concentrates | Closed | OP | 1964 | 1994 | Mo, Pyrite | 60 | 60 | 10 | | | | | |
| Rosen | Polimet | Concentrates | Closed | UG | 1950 | 1993 | Mo, Pyrite | 1 | 1 | 1 | | | | | |
| Tsar Arsen | Polimet | Concentrates | Closed | OP | 1982 | 1996 | Mo | | | 2 | | | | | |
| Zidrovo (Burgas) | Burgaskii Mines Ltd. | Concentrates | Closed | UG | 1980 | 1992 | | | 1 | 1 | | | | | |
| Assarel Medet | Asarel Invest Co. (75% VA Copper Invest) | Concentrates | Operating | OP | 1989 | | Au, Ag, Pyrite | | | 21 | 57 | 50 | 50 | 50 | 50 |
| Bradtze/ Strandja (Malko Turnovo Conc.) | Polimet | Concentrates | closed | OP, UG | 1950 | 1996 | Mo, W, Ag, Au, Pyrite | 2 | 2 | 2 | | | | | |
| Chelopech | Dundee Precious Metals Inc. | Concentrates | Operating | UG | 1954 | 2025 | Au, Ag, Se, Te, As, Co, Pyrite | 1 | 5 | 5 | 9 | 13 | 21 | 21 | 21 |
| Elatsite | Elatsite Copper Co. (Geotechmin group) | Concentrates | Operating | OP | 1981 | 2021 | Mo, Ag, Au | | | 20 | 45 | 45 | 45 | 45 | 45 |
| **Greece** | | Concentrates | | | | | | 3 | 1 | | | | | | 30 |
| Ermionis | Hellenic Chemical Products and Fertilizers Co. Ltd. | Concentrates | Closed | UG | | 1982 | | 3 | 1 | | | | | | |
| Skouries | Eldorado Gold Corp. | Concentrates | Developing | OP, UG | 2016 | | Au | | | | | | | | 30 |
| **Macedonia** | | Concentrates | | | | | | | 5 | 9 | 10 | 10 | 10 | 10 | 26 |
| **Macedonia** | | SX-EW | | | | | | | | | | | 3 | 3 | 7 |
| **Macedonia** | | Mine | | | | | | | 5 | 9 | 10 | 10 | 13 | 13 | 33 |
| Bucim/Cukar/Vrsnik | Solway Industries Ltd | Concentrates | Operating | OP | 1979 | | Au, Magnetite | | 5 | 9 | 10 | 10 | 10 | 10 | 10 |
| Bucim/Cukar/Vrsnik (SX-EW) | Solway Industries Ltd | SX-EW | Operating | OP | 2011 | | | | | | | | 3 | 3 | 3 |
| Ilovitza | Euromax Resources | Concentrates | Feasibility | OP | 2017 | 2040 | Au | | | | | | | | 16 |
| Kazandol | Sardic MC | SX-EW | Developing | | 2016 | | | | | | | | | | 4 |
| **Romania** | | Concentrates | | | | | | 24 | 24 | 34 | 24 | 10 | 10 | 15 | 35 |
| Moldova/ Florimunda/ Sasca | Romanian Government | Concentrates | Closed | OP, UG | | 1990 | Pb, Zn, Ag, Au, Mo | 12 | 12 | 12 | | | | | |
| Baita Bihor | Vast Resources plc 80%, Mineral Mining 20% | Concentrates | Developing | UG | 2015 | 2030 | Au, Ag, Zn, Pb, W, Mo | | | | 2 | | | 5 | 25 |
| Rosia Poieni | S.C. Cupru Min S.A. | Concentrates | Operating | OP | 1983 | | Ag, Au, Mo, Magnetite | | | 10 | 10 | 10 | 10 | 10 | 10 |
| Rovina Valley | Carpathian Gold Inc | Concentrates | Feasibility | | | | Au | | | | | | | | |
| Balan/ Ursului/ Fundu Moldovei | Romanian Government | Concentrates | Closed | UG | 1965 | 2007 | Zn, Pb, Ag, Au, As | 12 | 12 | 12 | 12 | | | | |

Table 2 (cont): Production Capacity of Copper Mines and Projects in the Balkans thousand tons copper

| Mine | Owner | Process | Status | Type | Start Up | Date of Closure | Other Metals | 1975 | 1980 | 1990 | 2000 | 2010 | 2014 | 2015 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Serbia** | | Concentrates | | | | | | 125 | 125 | 120 | 113 | 58 | 63 | 63 | 63 |
| Bor | RTB Bor | Concentrates | Closed | OP, UG | | 1991 | Au, Ag, Ge | 50 | 50 | 30 | | | | | |
| Cadinje | Slobodan Penezic-Krcun | Concentrates | Closed | UG | 1992 | 1996 | | | | | | | | | |
| Cerovo | RTB Bor | Concentrates | Operating | OP | 1994, 2011 | 2002 | | | | | 10 | | 5 | 5 | 5 |
| Jama | RTB Bor | Concentrates | Operating | UG | 1904 | | Au, Ag | | | | 8 | 8 | 8 | 8 | 8 |
| Majdanpek | RTB Bor | Concentrates | Operating | OP | 1961 | | Au, Zn, Pb | 75 | 75 | 60 | 65 | 30 | 30 | 30 | 30 |
| Veliki Krivelj | RTB Bor | Concentrates | Operating | UG | 1983 | | Mo | | | 30 | 30 | 20 | 20 | 20 | 20 |
| Timok Project | Rakita d.o.o., (Freeport-McMoRan Copper & Gold Inc. 55%, Reservoir Minerals 45%) | Concentrates | Exploration | | | | Au | | | | | | | | |
| Tulare | Avala Resources | Concentrates | Exploration | | | | Au, S | | | | | | | | |
| Exploration targets | Reservoir Minerals | NA | Exploration | | | | | | | | | | | | |
| KMC project | Euromax Resources | NA | Exploration | | | | | | | | | | | | |

More detailed information can be found in ICSG Directory of Copper Mines and Plants that was published in July 2015..

## SMELTER PRODUCTION

Based in the data available in ICSG database (starting 1970) there were no copper smelters operating in Greece nor in the former Yugoslavia countries of Bosnia and Herzegovina, Croatia, Kosovo, FYRO Macedonia, Montenegro and Slovenia. Based in ICSG Directory no copper smelter projects are planned for these countries in the near term future.

There has been some copper smelter production in Albania and Romania until the smelters closed in the nineties and early 2000. Currently only Bulgaria and Serbia are continuing producing copper anodes at operating smelters.

Chart 3

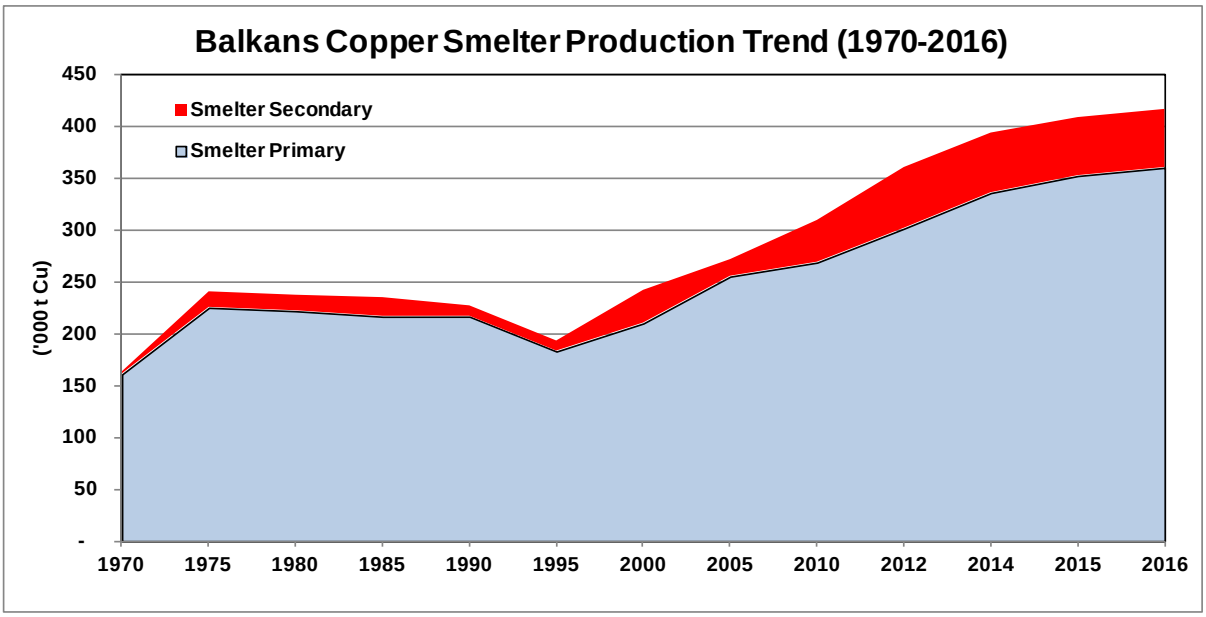



Chart 3 shows the trend in the Balkans copper smelter production since 1970. Production rose in the seventies from around 160kt to almost 240kt in 1980, stabilizing then at around that level for almost a decade. Like for mine production, smelter production then started to decline in early nineties impacted

by the collapse of the former eastern bloc regimes, uncompetitiveness of the state owned copper mines and the war in former Yugoslavia countries. Although production declined significantly in former Yugoslavia countries and smelters closed in Albania and Romania the Balkans total copper smelter production increased sharply after 1995 due to the expansion of smelter capacity in Bulgaria.

Copper smelter production in the Balkans rose from 190kt in 1994 to 393kt last year, which represents an increase of around 150%. Currently the Balkans output represents around 4% of the world copper smelter production comparing with a share of around 9% in 1970. Smelter production is predominantly from concentrates (85%) although some secondary production (from scrap) occurs mainly in Bulgaria (15%).

In 2015 and 2016, the Balkans smelter production is expected to continue increasing slightly mainly in Serbia due to the startup of the new smelter in March 2015. Production in 2016 is foreseen at 430kt Cu representing an increase of 10% when compared to 2014 production.

In terms of copper smelter production capacity there are no plans for expansion or new projects in the near term future with capacity expected to remain unchanged and current levels

Table 3 lists the Balkans countries that are currently, or have been producing copper anodes. Production is broken-down by primary (anodes originated from the treatment of concentrates) and secondary (anodes produced from the treatment of scrap).

Table 3 – Smelter Production by Country thousand tons copper

| Country | Smelter Production | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 | 2012 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albania | Smelter Primary | 6 | 6 | 8 | 11 | 12 | 3 | - | - | - | - | - | - | - |
| Albania | Smelter Secondary | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Albania | Smelter Total | 6 | 6 | 8 | 11 | 12 | 3 | - | - | - | - | - | - | - |
| Bulgaria | Smelter Primary | 48 | 55 | 50 | 43 | 34 | 98 | 163 | 225 | 247 | 269 | 305 | 302 | 305 |
| Bulgaria | Smelter Secondary | - | - | - | 5 | 1 | 6 | 17 | 15 | 39 | 56 | 55 | 55 | 55 |
| Bulgaria | Smelter Total | 48 | 55 | 50 | 48 | 35 | 103 | 180 | 240 | 287 | 325 | 360 | 357 | 360 |
| Romania | Smelter Primary | 20 | 40 | 48 | 40 | 27 | 22 | 16 | - | - | - | - | - | - |
| Romania | Smelter Secondary | - | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - |
| Romania | Smelter Total | 20 | 40 | 48 | 40 | 28 | 23 | 16 | - | - | - | - | - | - |
| Serbia | Smelter Primary | - | - | - | - | - | 60 | 31 | 30 | 21 | 32 | 31 | 51 | 70 |
| Serbia | Smelter Secondary | - | - | - | - | - | 3 | 14 | 1 | 1 | 2 | 3 | 1 | 1 |
| Serbia | Smelter Total | - | - | - | - | - | 63 | 45 | 31 | 22 | 35 | 33 | 51 | 71 |
| Yugoslavia 1) | Smelter Primary | 87 | 124 | 116 | 122 | 144 | - | - | - | - | - | - | - | - |
| Yugoslavia 1) | Smelter Secondary | 2 | 15 | 15 | 13 | 8 | - | - | - | - | - | - | - | - |
| Yugoslavia 1) | Smelter Total | 89 | 139 | 131 | 135 | 152 | - | - | - | - | - | - | - | - |
| **Balkans** | **Smelter Primary** | **161** | **225** | **222** | **216** | **216** | **183** | **210** | **255** | **269** | **301** | **336** | **352** | **375** |
| **Balkans** | **Smelter Secondary** | **2** | **15** | **15** | **18** | **10** | **10** | **32** | **16** | **40** | **59** | **58** | **56** | **56** |
| **Balkans** | **Smelter Total** | **163** | **240** | **237** | **234** | **226** | **193** | **241** | **271** | **309** | **360** | **393** | **408** | **431** |
| **%in World smelter production** | | **8.6%** | **9.5%** | **8.6%** | **7.7%** | **2.3%** | **1.9%** | **2.0%** | **2.0%** | **2.0%** | **2.2%** | **2.2%** | **2.2%** | **3.9%** |

1) Former Federal Republic of Yugoslavia until 1991

In the seventies and eighties the former Federal Republic of Yugoslavia was the biggest copper smelter producer in the Balkans with production occurring only in the Serbian territory. In the early nineties production was affected not only by the collapse of the regime but also by the war that followed. Production declined sharply in Serbia and Bulgaria became the biggest copper smelter producer in the Balkans, currently producing around 350kt of copper anodes.

Chart 4 A and Chart 4 B show the share of each Balkan country in the total copper smelter production, comparing the years 1970 and 2014. The charts highlight the growth in Bulgaria share and the loss of former Yugoslavia (Serbia territory) share.

Chart 4A

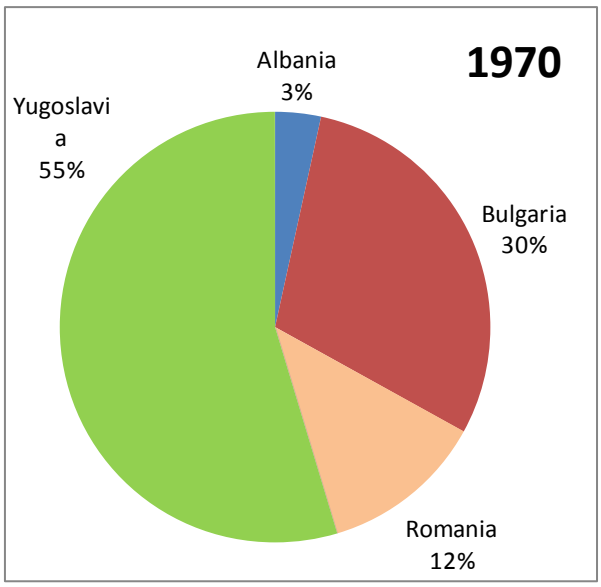
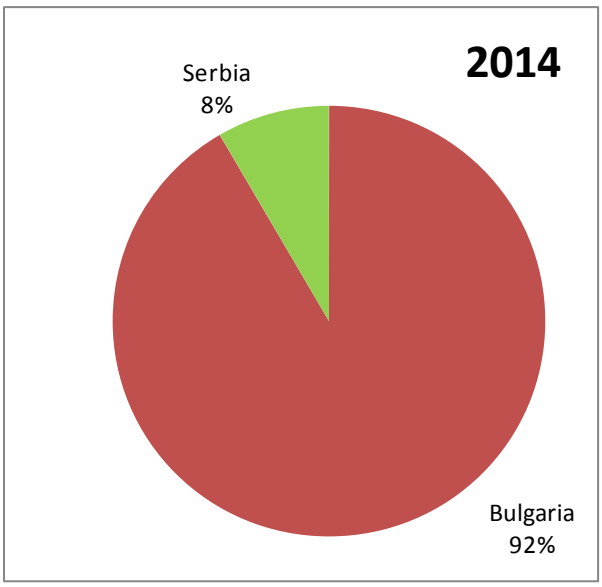



Chart 4B




In **Bulgaria**, there is only one copper smelter currently operating. Former MDK Georgi Damianov Smelter started production in 1958 and changed technology to Outokumpu flash in 1987. Although planned capacity was 120ktpy anodes output was limited to about 60ktpy due to a shortage of sulfur capture. The company was privatized in 1997 and the new owner (Union Miniere, then Cumerio) upgraded further the smelter to meet the environmental standards of the European Union. The overhaul allowed a capacity of 185 ktpy anode and 45ktpy cathode. The smelter was later on expanded to 330ktpy anodes and the refinery to around 210ktpy cathodes. In April 2008 Cumerio was acquired by Norddeutsche Affinerie (now Aurubis). The smelter treats concentrates and scrap. In June 2011 new investment program “Aurubis Bulgaria 2014” started (2011-2014), focused on productivity increase and improvement of the environmental performance in the plant to meet also future EU regulations. In May 2015, Aurubis announced a further investment plan at Pirdop of € 180 million named "Aurubis Bulgaria Spectrum 2018. The key planned projects to be undertaken in the period 2015-2018 are the upgrade of technological equipment for further protection of the environment, the improvement of the production processes which will enable operation at maximum available capacity of the plant, the construction of terminals for storage of raw materials and products across the ports of Burgas and Varna and realization of sustainable social development projects in the Srednogorie region.

There were two other copper smelters that closed in 1986 (Medet smelter) and in 2001 (Eliseina smelter). Capacity of both smelters was below 20ktpy anode. Dundee Precious Metals had plans to build a 100ktpy copper smelter at the Chelopech mine site but in Jan 2010 frozen plans and instead, in March 2010 bought the Tsumeb smelter in Namibia that treats Chelopech complex concentrates.

Bulgaria copper smelter production was around 50ktpy anodes in the seventies and eighties. Through expansions and production improvement at Pirdop, Bulgaria smelter production increased to 360kt last year and is expected to remain at this level in the near future. Pirdop smelter is integrated with a refinery although the refinery capacity is lower at 240ktpy. The anodes that are not treated at the Pirdop refinery are sent for treatment at other Aurubis refineries in Germany or Belgium.

In **Serbia**, smelter and refined production has always been in the hands of RTB Bor, a state-owned company. The smelter started operations in 1961 and undergone various stages of modernization, with the most significant in 1971 when a second line was installed and in 1981 when the old electrostatic filters were replaced. Capacity was around 160ktpy anode but actual production declined sharply during the war and international embargo and later on was constrained by lack of investment in new technology and environmental issues (sulphur emissions). Since late nineties production has been below 40ktpy.

In 2007 and 2008 Serbia's Privatisation Agency launched three tenders for the privatization of RTB Bor but they all failed and the privatization process was cancelled. In 2010 RTB Bor and SNC Lavalin signed a 175 million euro contract to build a new copper smelter and a sulphuric acid plant. The new smelter would comply with EU standards and the new acid plant would enable 98.5% of sulfur dioxide to be refined into sulfuric acid (only 30% before).

In 2014 a new Outotec flash furnace with a capacity of 80ktpy anode was built replacing the old reverbatory furnace. The first anodes from the new plant were produced in March 2015. Production for 2015 is planned at 50kt and is expected to increase to 70kt in 2016.

In **Albania** copper smelter production was around 6ktpy Cu in 1970 increasing to 12ktpy in 1990 but after the end of the communist regime state owned companies encountered difficulties to be competitive in the international markets and were forced to close. Production ceased in the country in 1997.

There were three copper smelters operating in Albania: Kukes (Reverbatory), Lac (Blast Furnace) and Rubik (Reverbatoory). Currently all three smelters remain closed and there is no copper smelting production in Albania.

The Kukes smelter started in 1964 with a capacity of 5ktpy and the anodes were sent to the Lac refinery. Lac smelter was integrated with a refinery and anode production capacity was around 10ktpy. Rubik reverbatory furnace (capacity of 5ktpy) was integrated with a fire refinery.

Smelter production in **Romania** was around 20kt in 1970 increasing to around 50kt in the early eighties and stabilizing at around 40kt until the end of the decade. With mine production declining and lack of investment smelter production initiated a downward trend until it stopped completely in 2003. There were two smelters in the country: the Baie Mare smelter (Outokumpu Flash) was built in 1956 and the Zlatna smelter, also an Outokumpu Flash started production in 1968. Both smelters closed in 2004.

Additional information on the Balkan countries' copper smelters can be found in Table 4 (next page) that lists the closed and operating copper smelters in the period 1975-2018. Table 4 presents capacity data as well as information on ownership, smelter process, type, status, startup and closure dates and raw materials used based on ICSG Directory of Copper Mines and Plants.

Table 4: Copper Smelter Production Capacity in the Balkans thousand tons copper

| Smelter | Operator/Owner(s) | Process | Status | Start Up | Date of Closure | Raw Materials | 1975 | 1980 | 1990 | 2000 | 2010 | 2014 | 2015 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Albania** | | Smelters | | | | | 10 | 20 | 19 | | | | | |
| Kukes (Gjegjan) | Albanian Government | Reverberatory | Closed | 1964 | 1992 | Concs. | 5 | 5 | 5 | | | | | |
| Lac Smelter | Albanian Government | Blast Furnace | Closed | 1979 | 1997 | Concs. | | 10 | 7 | | | | | |
| Rubik Primary | Albanian Government | Reverberatory | Closed | 1936 | 1997 | Concs. | 3 | 3 | 5 | | | | | |
| Rubik Secondary | Albanian Government | Reverberatory (S) | Closed | 1936 | 1995 | Scrap | 2 | 2 | 2 | | | | | |
| **Bulgaria** | | Smelters | | | | | 91 | 91 | 134 | 184 | 330 | 360 | 360 | 360 |
| Eliseina | Eliseina Ltd. | Blast Furnace (S) | Closed | 1962 | 2001 | Scrap | 11 | 11 | 14 | 14 | | | | |
| MDK G Damianov Smelter | Georgi Damyanov Copper Co. | Electric | Closed | 1958 | 1987 | Concs. | 60 | 60 | | | | | | |
| Pirdop (smelter) | Aurubis (99.77%) | Outokumpu Flash | Operating | 1987 | | Concs, Scrap | | | 120 | 170 | 330 | 360 | 360 | 360 |
| Medet Smelter | Medet Mining Combine | Reverberatory | Closed | | 1986 | Concs. | 20 | 20 | | | | | | |
| Chelopech (smelter) | Dundee Precious Metals | Unknown | Planned | | | Concs. | | | | | | | | 0 |
| **Romania** | | Smelters | | | | | 50 | 50 | 75 | 75 | | | | |
| Baia Mare (smelter) | Cuprom S.A. | Outokumpu Flash | Closed | 1956 | 2004 | Concs. | 50 | 50 | 35 | 35 | | | | |
| Zlatna Smelter | Zlatna Metallurgical | Outokumpu Flash | Closed | 1989 | 2004 | Concs. | | | 40 | 40 | | | | |
| **Serbia** | | Smelters | | | | | 145 | 145 | 170 | 170 | 170 | 80 | 80 | 80 |
| Bor (smelter) | RTB Bor | Reverberatory | Operating | 1933 | | Concs, Scrap | 145 | 145 | 170 | 170 | 170 | 80 | 80 | 80 |

More detailed information can be found in ICSG Directory of Copper Mines and Plants.

## REFINED PRODUCTION

Based in the data available in ICSG database (starting 1970) there were no copper refineries operating in Greece nor in the former Yugoslavia countries of Bosnia and Herzegovina, Croatia, Kosovo, Montenegro and Slovenia. Based in ICSG Directory no copper refinery projects are planned for these countries in the near term future.

There has been some copper refinery production in Albania and Romania until the refineries closed in the nineties and early 2000. Currently only Bulgaria and Serbia are continuing producing electrolytic copper anodes and FYRO Macedonia started producing electrowining cathodes in 2011.

Chart 5

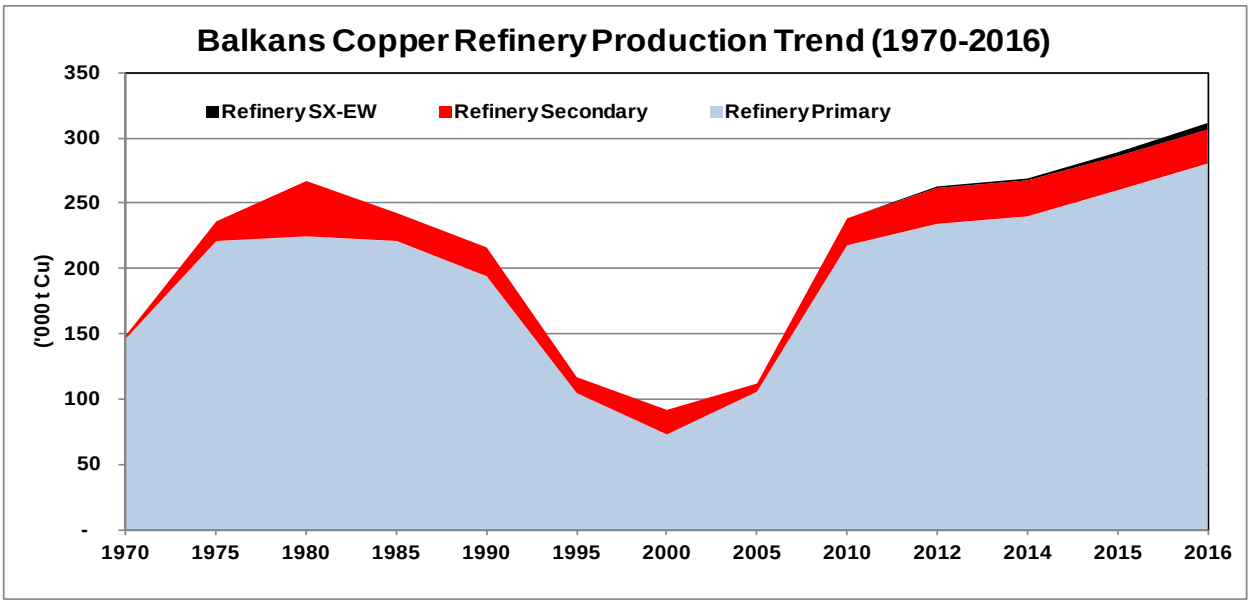



Chart 5 shows the trend in the Balkans copper refined production since 1970. Refined production follows almost the same trend as smelter production as most plants are smelter/refinery integrated.

Production rose from around 150kt cathodes in 1970 to almost 270kt in 1980, stabilizing then at around 250kt until the collapse of the former eastern bloc regimes. Production initiated a declining trend until early 2000 where it bottomed at around 80kt cathode. Since them, and due to capacity expansion in Bulgaria, the Balkans copper refined production increased gradually reaching 270kt in 2014. However production declined significantly in former Yugoslavia countries and refineries closed in Albania and Romania.

Currently the Balkans refined copper output represents around 1.5% of the world copper refinery production comparing with a share of around 3% in the eighties. Refinery production is predominantly from electrolytic refineries (99%) although some small electrowining production occurs in FYRO Macedonia. Primary refined production represents 90% of the total refined output and secondary production (from scrap) represents 10%.

In 2015 and 2016, the Balkans refinery production is expected to continue increasing mainly in Serbia due to the startup of the new BOR smelter in March 2015 that will enable the treatment of more anodes at the intergraded refinery. Production in 2016 is foreseen at around 310kt Cu representing an increase of 15% when compared to 2014 production.

In terms of copper refinery production capacity there are no plans for expansion or new projects in the near term future with capacity expected to remain unchanged and current levels

Table 5 lists the Balkans countries that are currently, or have been producing copper cathodes. Production is broken-down by primary (electrolytic cathodes originated from the treatment of concentrates), secondary (electrolytic cathodes produced from the treatment of scrap) and SX-EW (cathodes originated form electrowining process).

Table 5 Refinery Production by Country

thousand tons copper

| Country | Refinery Production | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 | 2012 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albania | Refinery Primary | 6 | 6 | 8 | 11 | 11 | 3 | - | - | - | - | - | - | - |
| Albania | Refinery Secondary | - | - | - | 0 | - | - | - | - | - | - | - | - | - |
| Albania | Refinery Total | 6 | 6 | 8 | 11 | 11 | 3 | - | - | - | - | - | - | - |
| Bulgaria | Refinery Primary | 38 | 51 | 60 | 56 | 14 | 20 | 28 | 57 | 196 | 202 | 209 | 209 | 210 |
| Bulgaria | Refinery Secondary | - | 1 | 3 | 5 | 10 | 6 | 3 | 3 | 20 | 25 | 25 | 25 | 25 |
| Bulgaria | Refinery Total | 38 | 52 | 63 | 61 | 24 | 25 | 31 | 60 | 216 | 227 | 234 | 234 | 235 |
| Macedonia | Refinery Primary | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Macedonia | Refinery SX-EW | - | - | - | - | - | - | - | - | - | 1 | 2 | 3 | 3 |
| Macedonia | Refinery Secondary | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Macedonia | Refinery Total | - | - | - | - | - | - | - | - | - | 1 | 2 | 3 | 3 |
| Romania | Refinery Primary | 16 | 40 | 41 | 32 | 25 | 22 | 14 | 19 | - | - | - | - | - |
| Romania | Refinery Secondary | - | - | 24 | 3 | 4 | 4 | 2 | 2 | - | - | - | - | - |
| Romania | Refinery Total | 16 | 40 | 65 | 35 | 29 | 26 | 15 | 21 | - | - | - | - | - |
| Serbia | Refinery Primary | - | - | - | - | - | 60 | 31 | 30 | 21 | 32 | 31 | 51 | 70 |
| Serbia | Refinery Secondary | - | - | - | - | - | 3 | 14 | 1 | 1 | 2 | 3 | 1 | 1 |
| Serbia | Refinery Total | - | - | - | - | - | 63 | 46 | 31 | 22 | 35 | 33 | 52 | 71 |
| Yugoslavia 1) | Refinery Primary | 87 | 124 | 116 | 122 | 144 | - | - | - | - | - | - | - | - |
| Yugoslavia 1) | Refinery Secondary | 2 | 14 | 15 | 13 | 8 | - | - | - | - | - | - | - | - |
| Yugoslavia 1) | Refinery Total | 89 | 138 | 131 | 135 | 152 | - | - | - | - | - | - | - | - |
| **Balkans** | **Refinery Primary** | **147** | **221** | **224** | **221** | **194** | **105** | **73** | **106** | **218** | **234** | **240** | **260** | **280** |
| **Balkans** | **Refinery SX-EW** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **2** | **3** | **3** |
| **Balkans** | **Refinery Secondary** | **2** | **15** | **42** | **21** | **22** | **12** | **19** | **6** | **21** | **27** | **28** | **26** | **26** |
| **Balkans** | **Refinery Total** | **149** | **236** | **267** | **242** | **216** | **117** | **92** | **112** | **238** | **263** | **269** | **289** | **309** |
| **% in World refinery production** | | **2.1%** | **3.1%** | **3.0%** | **2.6%** | **2.0%** | **1.0%** | **0.6%** | **0.7%** | **1.3%** | **1.3%** | **1.2%** | **1.2%** | **1.2%** |

1) Former Federal Republic of Yugoslavia until 1991

In the seventies and eighties, and like for smelter production, the former Federal Republic of Yugoslavia was the biggest refined copper producer in the Balkans with production occurring only in the Serbian territory. In the early nineties production was affected not only by the collapse of the

regime but also by the war that followed. Production declined sharply in Serbia and Bulgaria became the biggest refined copper producer in the Balkans, currently producing around 235kt of copper cathodes.

Chart 6 A and Chart 6 B show the share of each Balkan country in the total refined copper production, comparing the years 1970 and 2014. The charts highlight the growth in Bulgaria share and the loss of former Yugoslavia (Serbia territory) share.

Chart 6A

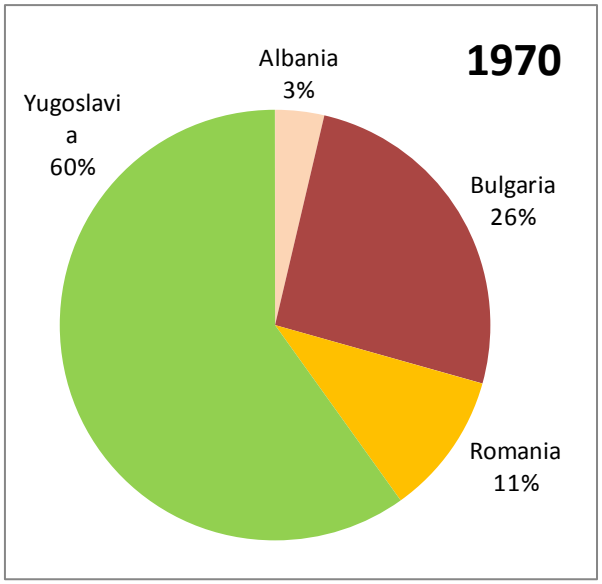
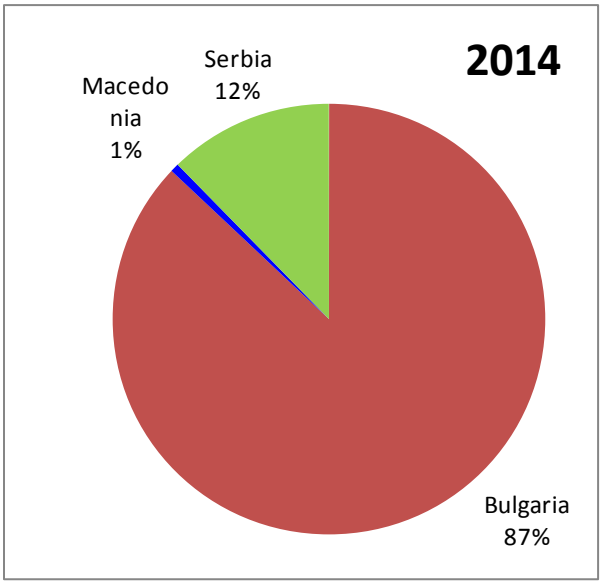



Chart 6B




In **Bulgaria**, the Medet refinery (20ktpy cathode) closed in 1986. The Pirdop (Aurubis) integrated refinery started production in 1958 with a capacity of 40ktpy and was later expanded to the actual 240ktpy cathode. Detailed information about this smelter/refinery plant was already provided in smelter section. Currently there are no new refineries projects planned for Bulgaria.

Bulgaria refinery production was around 50ktpy cathodes in the seventies and eighties. Through expansions and production improvement at Pirdop, Bulgaria refined production increased to 234kt last year and is expected to remain at this level in the near future.

As said in the smelter section, **Serbia** smelter and refined production has always been in the hands of RTB Bor, a state-owned company. The refinery electrolytic plant was built in two phases. The first plant was built in 1933 and the second one was built in 1969 which is currently used for production with a capacity of 120ktpy cathodes. The anode slimes from the refining process are sent to the Precious Metals Plant (Zlatara) that started operation in 1969 for production of gold, silver, platinum, palladium and selenium.

Although Serbia refinery capacity is around 120ktpy actual production declined sharply during the war and international embargo and later on was constrained by lower availability of anodes from the integrated smelter as explained in the smelter section. Since late nineties production has been below 40ktpy.

With the new integrated 80ktpy smelter that started production in March 2015 availability of anodes will increase enabling higher refined copper production levels. Production for 2015 is planned at around 50kt and is expected to increase to 70kt in 2016.

In **Albania** refined copper production trend is similar to the smelter production trend. Refined production was around 6ktpy Cu in 1970 increasing to around 11ktpy in 1990 but after the end of the communist regime state owned companies encountered difficulties to be competitive in the international markets and were forced to close. Production ceased in the country in 1997.

There were three copper refineries operating in Albania: Lac (Electrolytic) and Rubik (Electrolytic and Fire refining plants). Currently all three refineries remain closed and there is no copper refining production in Albania.

In **Romania**, refined copper production was around 15kt in 1970 increasing to around 65kt in the early eighties and initiating then a downward trend in line with smelter production constrains as explained in the smelter section. Production stopped completely in 2009 when the Baia Mare refinery closed. There were two copper refineries in the country: the Baie Mare electrolytic refinery that was built in 1965 and the Zlatna electrolytic refinery that started production in 1984 and closed in 2004.

Additional information on the Balkan countries' copper refineries can be found in Table 6 that lists the closed and operating copper refineries in the period 1975-2018. Table 4 presents capacity data as well as information on ownership, refinery process, type, status, startup and closure dates and raw materials used based on ICSG Directory of Copper Mines and Plants.

Table 6: Copper Refinery Production Capacity in the Balkans

thousand tons copper

| Refinery | Operator/Owner(s) | Process | Status | Start Up | Date of Closure | Raw Materials | 1975 | 1980 | 1990 | 2000 | 2010 | 2014 | 2015 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Albania** | | **Refinery** | | | | | **7** | **16** | **17** | | | | | |
| Lac Refinery | Albanian Government | Electrolytic | Closed | 1979 | 1997 | Anode | | 9 | 10 | | | | | |
| Rubik Electrolytic | Albanian Government | Electrolytic | Closed | 1966 | 1997 | Anode | 5 | 5 | 5 | | | | | |
| Rubik Refinery | Albanian Government | Fire Refining (S) | Closed | 1966 | 1995 | Scrap | 2 | 2 | 2 | | | | | |
| **Bulgaria** | | **Refinery** | | | | | **60** | **60** | **60** | **45** | **220** | **240** | **240** | **240** |
| Medet Refinery | Medet Mining Combine | Fire Refining | Closed | | 1986 | Blister | 20 | 20 | | | | | | |
| Pirdop | Aurubis (99.77%) | Electrolytic | Operating | 1958 | | Anode | 40 | 40 | 60 | 45 | 220 | 240 | 240 | 240 |
| **Macedonia** | | **Electrolytic** | | | | | | **9** | **9** | | | | | |
| **Macedonia** | | **Electrowinning** | | | | | | | | | | **3** | **3** | **7** |
| **Macedonia** | | **Refinery** | | | | | | **9** | **9** | | | **3** | **3** | **7** |
| Radovis | RTB Bor | Electrolytic | Closed | | 1991 | Anode | | 9 | 9 | | | | | |
| Bucim/Cukar/Vrsnik (SX-EW plant) | Solway Industries Ltd | Electrowinning | Operating | 2011 | | Leach | | | | | | 3 | 3 | 3 |
| Kazandol (SX-EW) | Sardic MC | Electrowinning | Developing | 2016 | | Leach | | | | | | | | 4 |
| **Romania** | | **Refinery** | | | | | **50** | **50** | **80** | **75** | | | | |
| Baia Mare | Cuprom S.A. | Electrolytic | Closed | 1965 | 2009 | Primary & Secondary anode | 50 | 50 | 40 | 35 | | | | |
| Zlatna | Zlatna Metallurgical Enterprise for Nonferrous Metals | Electrolytic | Closed | 1984 | 2004 | Primary & Secondary anode | | | 40 | 40 | | | | |
| **Serbia** | | **Refinery** | | | | | **165** | **165** | **165** | **120** | **120** | **120** | **120** | **120** |
| Bor (refinery) | RTB Bor | Electrolytic | Operating | 1933 | | Anode | 165 | 165 | 165 | 120 | 120 | 120 | 120 | 120 |

**REFINED USAGE and SEMIS PRODUCTION**

Refined usage level is determined by the use of copper cathodes by the semis industry for the production of semis products such as copper wirerod, copper tubes, etc. Semis plants can also use scrap for the production of brass mill products such as copper alloy tubes, sheets, etc.

In the seventies and eighties copper refined usage was centered in Albania, Bulgaria, Greece, Romania and former Yugoslavia. The impact of the collapse of the former eastern bloc on the copper semis industry was similar to that on the copper smelting and refining industries. In the early nineties, mainly due to plant closures, refined usage declined significantly in Bulgaria, Romania and Serbia and stopped completely in Albania. Thereafter, through privatizations and technical enhancements usage improved in Bulgaria and Greece before declining again.

Chart 7

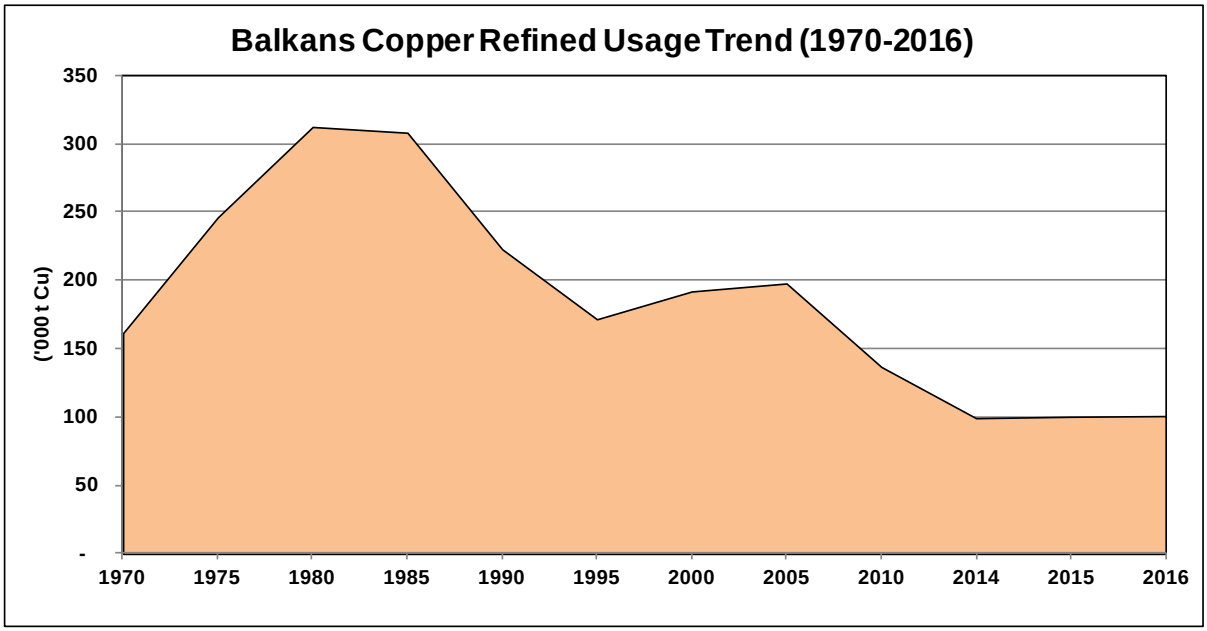



Chart 7 shows the trend in the Balkans copper refined usage since 1970. Refined usage rose above 300kt cathodes in early eighties stabilizing there before it declined sharply to around 170kt in 1995 impacted by the collapse of the former eastern bloc regimes. Usage recovered then around 190kt in the first half of last decade before it declined again due to plant closures and reaching around 100kt in 2014.

Currently the Balkans refined copper usage represents around 0.5% of the world copper refined usage comparing with a share of around 3% in 1970.

In 2015 and 2016, the Balkans refined usage is expected to maintain the same level as in 2014 as no new semis plants, nor expansions, are expected to occur

Table 5 on next page lists the Balkans countries that are currently, or have been using copper cathodes for the production of semis products. Albania refined usage was around 10ktpy before the collapse of the eastern bloc and due to subsequent semis plant closures was nil by the year 1995. A similar scenario happened in Romania where usage was around 60ktpy in the eighties declining to around 17kt in 2000. Through privatization, the new owner Cuprom improved semis production levels to around 40kt in 2007 but then semis production ended in 2010 and therefore refined copper usage stopped.

Table 5 – Refined Copper Usage by Country thousand tons copper

| Country | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albania | 3 | 7 | 7 | 12 | 11 | 0 | - | - | - | - | - | - |
| Bulgaria | 35 | 51 | 67 | 61 | 32 | 14 | 15 | 38 | 38 | 25 | 25 | 25 |
| Croatia | | | | | | - | - | - | - | 18 | 18 | 18 |
| Greece | 12 | 18 | 35 | 39 | 54 | 80 | 135 | 100 | 63 | 20 | 20 | 20 |
| Romania | 22 | 61 | 82 | 52 | 33 | 27 | 17 | 24 | 1 | - | - | - |
| Slovenia | - | - | - | - | - | 1 | 1 | 1 | - | - | - | - |
| Serbia | | | | | | 50 | 25 | 35 | 36 | 36 | 38 | 38 |
| Yugoslavia 1/ | 91 | 111 | 123 | 146 | 93 | | | | | | | |
| **Balkans Total** | **159** | **240** | **306** | **297** | **212** | **172** | **192** | **198** | **137** | **99** | **101** | **101** |
| **%in World refined usage** | **3.0%** | **4.6%** | **3.4%** | **3.0%** | **2.0%** | **1.4%** | **1.3%** | **1.2%** | **0.7%** | **0.4%** | **0.4%** | **0.4%** |

1/ Former Federal Republic of Yugoslavia until 1991

In Bulgaria, production was also negatively affected in the early nineties by the political changes in the region declining form around 60ktpy in the late eighties to around 15kt in the nineties/early 2000. Production then improved in 2005 with the relocation of Alcor rolling mill plant from Greece to Bulgaria but then declined again with the relocation back to Greece in 2012. Current refined usage levels are around 25ktpy.

Former Yugoslavia was the biggest refined copper user in the region in the seventies and eighties. After the split of the Yugoslavian territories, Serbia continued to produce wirerod and therefore consuming cathodes although at a much lower rate (38ktpy). Copper usage started in Croatia in 2011 with the commission a new 18ktpy wirerod plant (Jakovlje) from Eurocable.

In Greece, refined usage increased strongly after the collapse of the former eastern bloc with the country probably gaining market share left by the former eastern bloc countries struggling to keep their semis production levels. Usage in Greece increased from around 40kt in 1985 to 135kt in 2000. Refined usage then decline with the relocation of the Alcor rolling plant to Bulgaria in 2005. The plant was relocated back to Greece in 2012 but another wirerod plants closed in the country leading to current copper refined usage level at around 20ktpy.

Chart 6 A and Chart 6 B show the share of each Balkan country in the total refined copper usage, comparing the years 1970 and 2014. The charts highlight the growth in Greece share and the loss of Romania and Albania shares.

Chart 6A

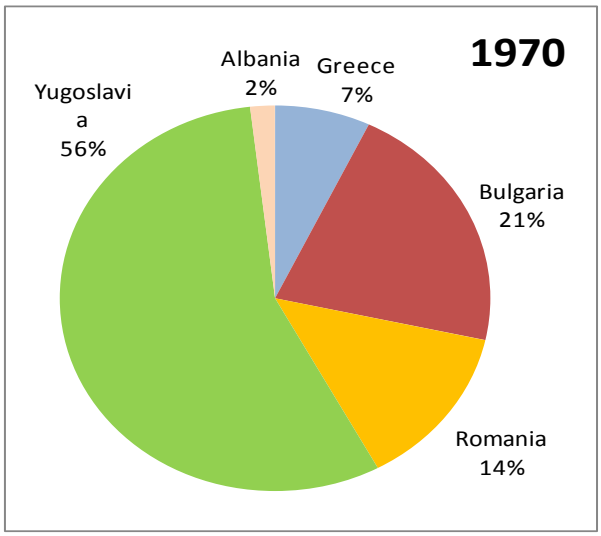
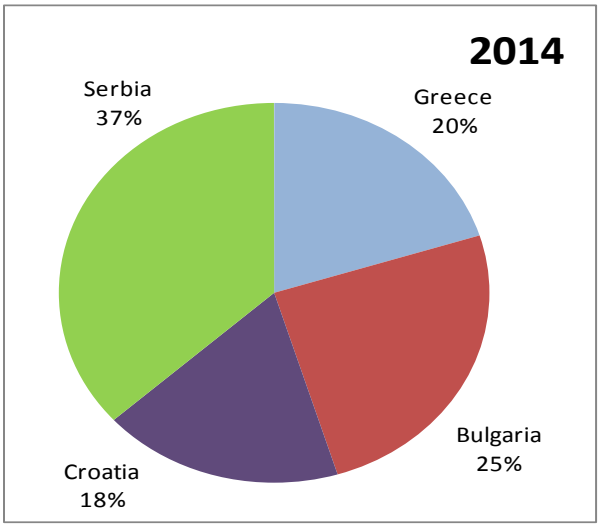



Chart 6B



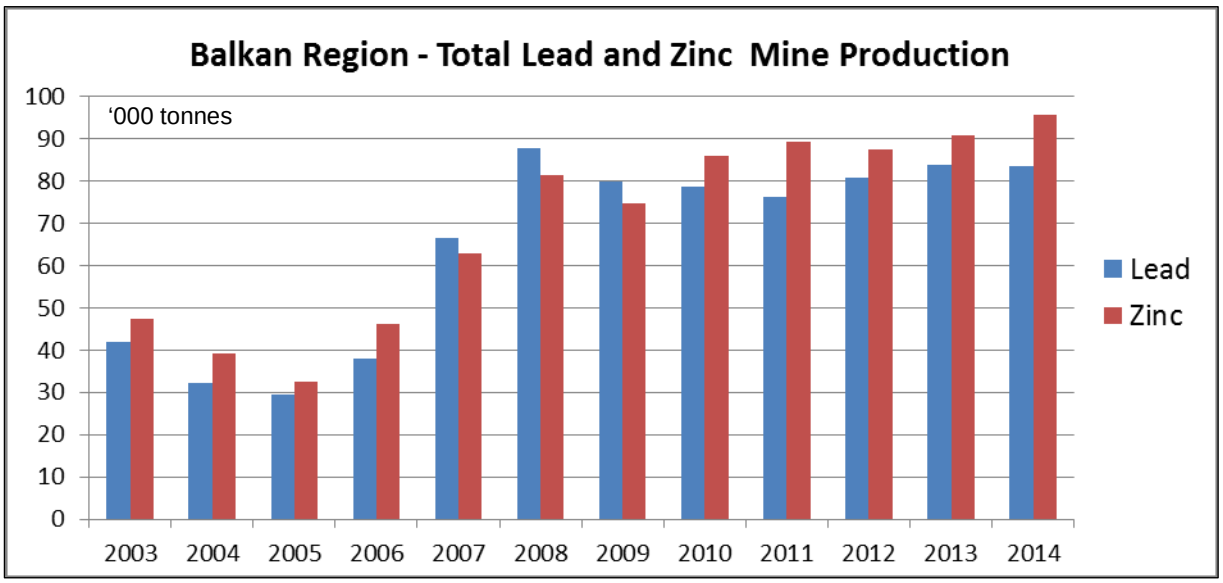
# IV. Lead and Zinc in the Balkan Region

**Mine Production**

Within the Balkan region, seven countries have lead and zinc mines currently in operation: Bosnia & Herzegovina, Bulgaria, Greece, FYRO Macedonia, Montenegro, Romania and Serbia. In 2014, FYRO Macedonia accounted for almost half of the lead and 20% of the zinc obtained from ores mined in the Balkans, being the top producer of both lead and zinc concentrates. The second largest producer of zinc concentrates was Greece with around 14% of the total.

After a strong growth (yearly growth rate averaged 36%) from its 29.6 thousand tonnes (kt) low in 2005, total lead mine production (in metal content) peaked in 2008 at 87.8kt, falling to 76.4kt in 2011, and partially recovering to 84.5kt in 2014. It is, however, reasonable to state that total production of lead concentrates has been relatively stable in the region since 2009. These comments and further analysis in this paper relate to the period between 2003 and 2014.

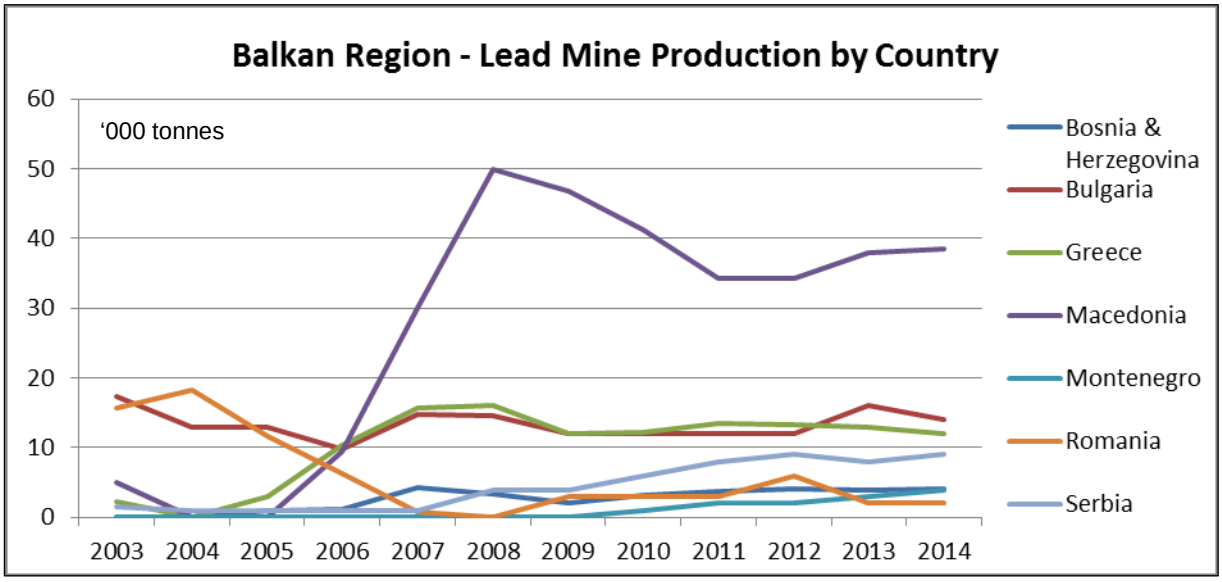
Total zinc mine production (in metal content) had its lowest point in 2005 (same year as lead) at 32.6kt, increasing sharply to 81.4kt in 2008, followed by a decline to 74.8 in the subsequent year. Since then, production of zinc concentrates in the region has increased every year to its peak in 2014 of 95.5kt, with 2012 being the only exception to this recent continuous growth, since production decreased (even if moderately) relatively to its precedent year.



**Mine Production by Country**

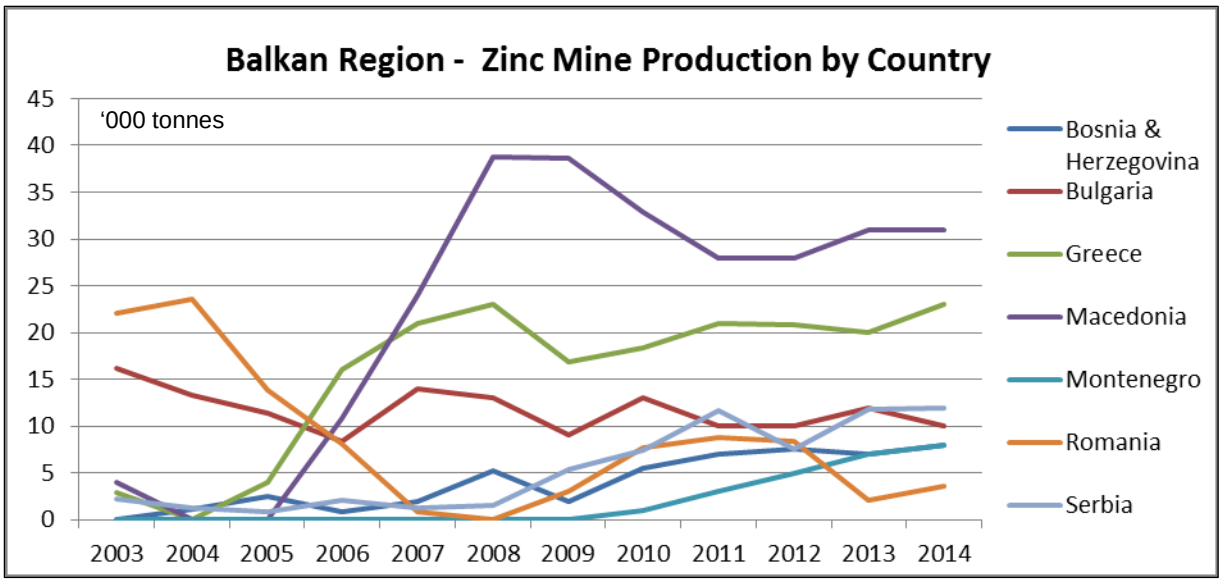
FYRO Macedonia has been since 2006 the biggest producer of lead concentrates in the Balkan region by a large amount (33% of total production in 2014), followed by Bulgaria and, immediately after, Greece.

In 2014, Serbia's production almost reached Greece's level, after a consistent (though relatively modest) growth since 2006, when production was close to zero. On the contrary, Romania, once the biggest producer (18kt in 2004) has declined sharply between 2004 and 2007, and is now the smallest of the group, generating only 2kt in 2014.




Regarding zinc mine production, the distribution amongst the different economies in the Balkan region has been more balanced. FYRO Macedonia has been the main producer since 2007, but its dominance was recently reduced, and in 2014 the difference to the second producer, Greece, didn't exceed 8kt.

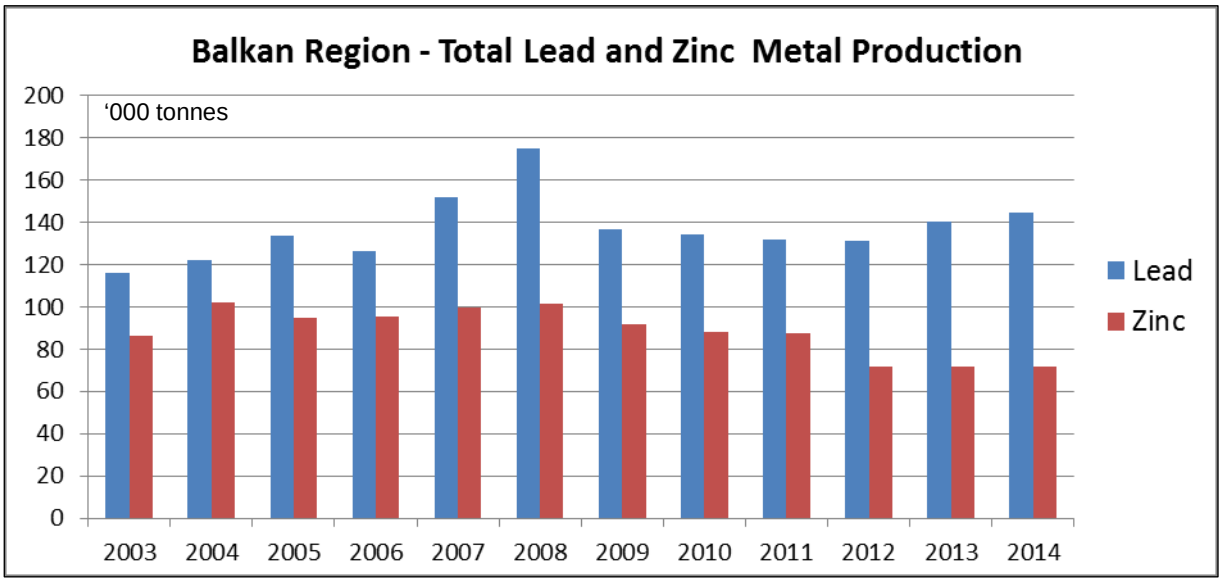
As in the case of lead concentrates production, Romania moved from being the biggest producer in early years of this series to the smallest in 2014. However, its production last year was relatively close to that of Bosnia, Bulgaria, Serbia, and Montenegro, a country that has been increasing its production steadily since its mine, Supla Stijena, opened in 2010.



**Metal Production**

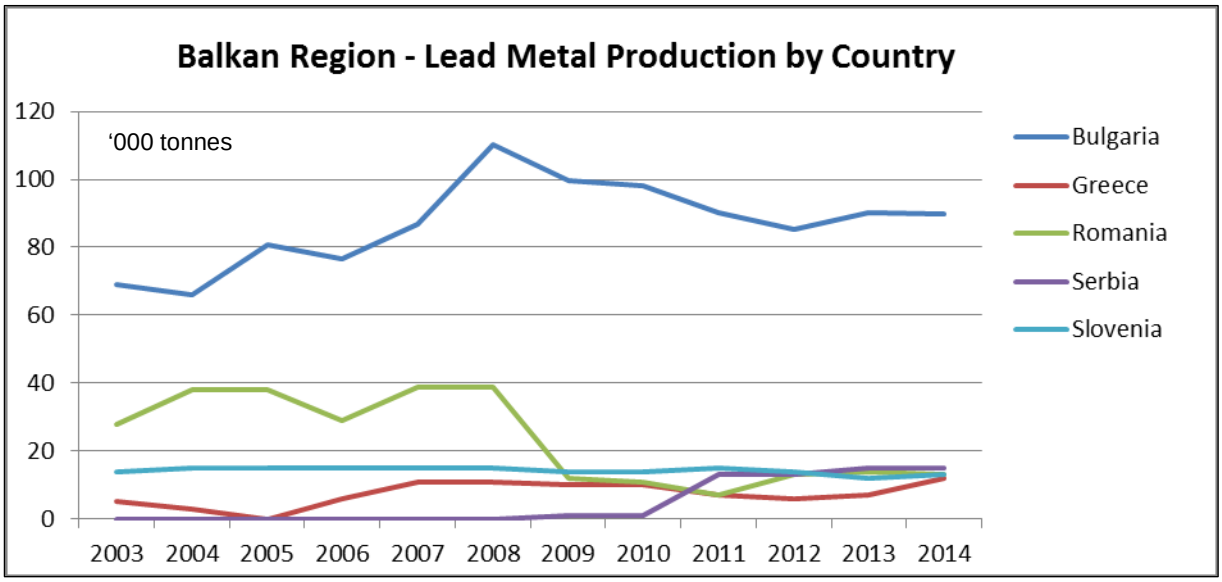
In contrast to the production of concentrates, refined lead output in the Balkan region has been consistently higher than zinc's production. However, and despite a small increase in the last three years, lead metal output in 2014 was still 30kt lower than the peak (175kt) achieved in 2008.

Production of zinc metal in the Balkans declined every year between 2008 and 2012, becoming stable at around 72kt since then, the lowest level since 2003. In 2008, production in the Balkans was identical to that of 2004 (102kt), when it reached its peak during the period between 2003 and 2014.

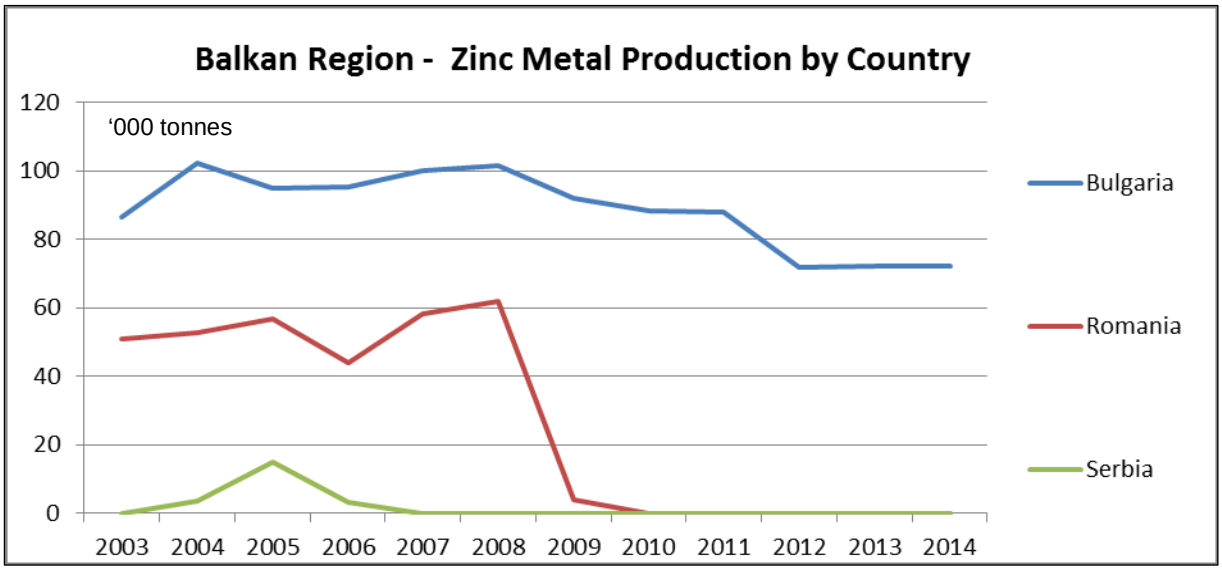


**Metal Production by Country**

Bulgaria clearly dominates refined lead production in the Balkans, accounting for 62% of total output in 2014. Bulgaria's secondary output was similar to what was produced in Greece or Romania until 2007 (annual average of around 15kt). However, from 2008 onwards new added capacity brought Bulgaria's secondary lead production to at least twice as much the production in each one of these two countries. The opening of a lead recycler in Serbia in 2011 has turned this country into the second largest producer of refined lead in 2014, at close to 11% of the total. Still, in 2014 production quantities in Serbia (15kt) were well below Bulgaria's 90kt and almost identical to the remaining countries. An even larger difference between Bulgaria and the other countries in the Balkans can be observed regarding primary lead production. In fact, this was the only country showing relevant primary production last year, at 59kt (Serbia was the only producer of primary lead apart from Bulgaria, but generating much smaller amounts). In 2007, Romania was the source of more than one quarter of total refined lead produced in the Balkans. Last year, its share in total production was similar to the Greek's, at less than 10%.

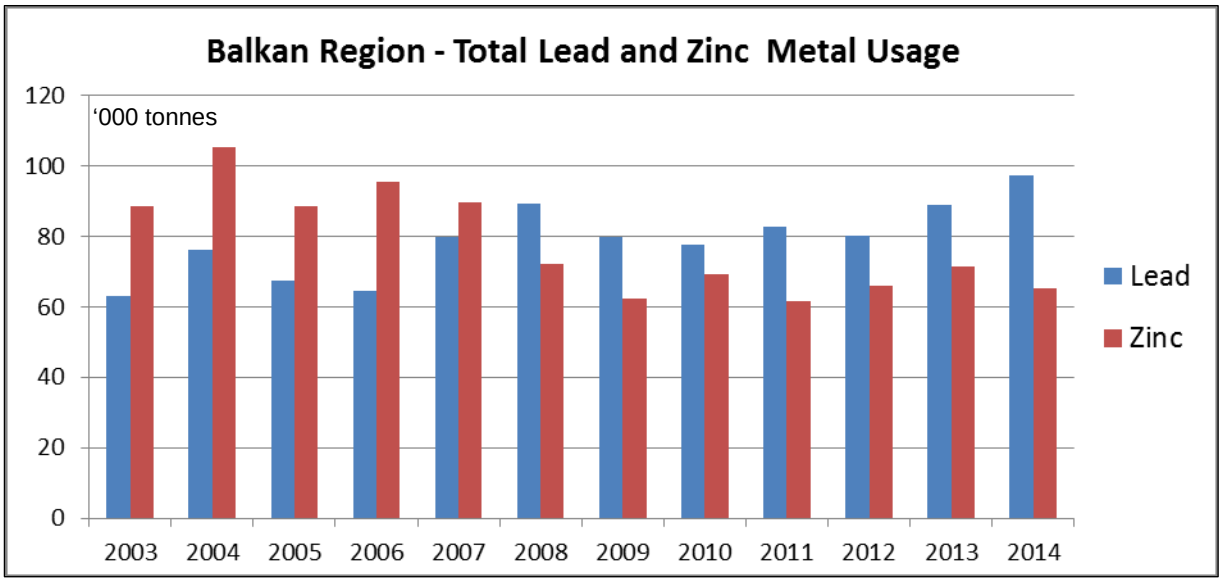



After the closure of the Romanian zinc refinery in 2009, Bulgaria became the only zinc producer in the Balkan region. Its production has been declining since 2008, when output was 102kt, to 72kt achieved last year. Between 2004 and 2006, Serbia produced a relatively small amount of refined zinc.



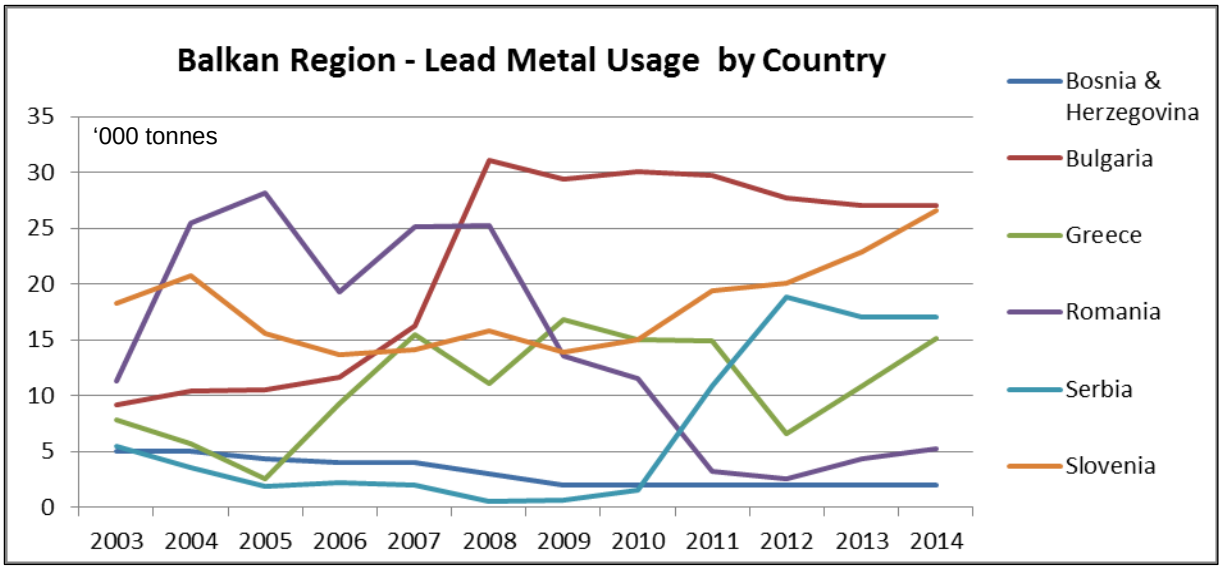
**Refined Lead and Zinc Metal Usage**

Between 2003 and 2007, zinc usage in the Balkan region was higher than that of lead. After this period, zinc usage was more adversely affected by the economic cycle, falling more than 42% between its peak in 2004 and the year 2009, when it hit its lowest level at 63kt. Since then, recovery has been sluggish: in 2014 zinc usage in the region was not higher than 66kt, a fall of 6kt from previous year's level.Lead usage in the Balkans has been more stable, and above zinc's since 2008 when it reached 89kt. After 2008 it declined to 78kt in 2010 and has recovered since then. In the last two years of the period in analysis, lead usage growth rate averaged 10% per year, reaching a peak of 97kt in 2014.

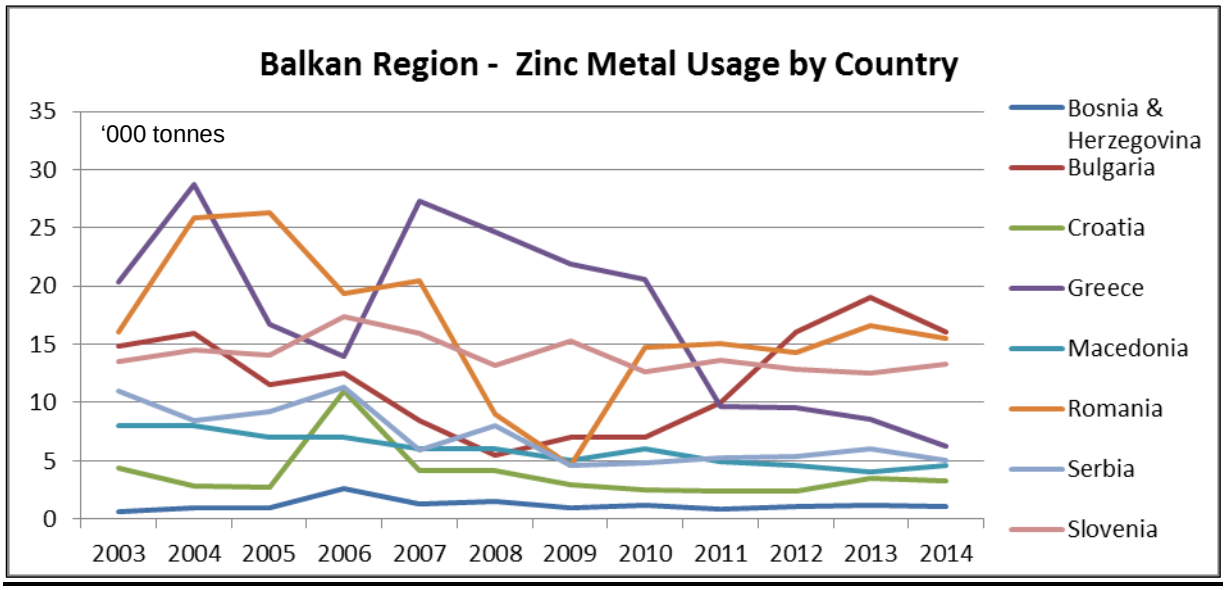



**Refined Lead and Zinc Usage by Country**

Refined lead usage between 2003 and 2014 has been minimal in Albania, Croatia and FYRO Macedonia, so these countries were not included in the chart below. With a sharp increase since 2009, Slovenia matched Bulgaria's usage in 2014; at 27kt. Bulgaria had been since 2008 the highest user of refined lead in the Balkan region. Serbia's usage was the third largest in 2014, followed by Greece at 18kt. Romania, the most important user of lead metal between 2004 and 2007, has showed a steep decline since then, not using more than 5kt of refined lead last year, above the residual 2kt observed in Bosnia & Herzegovina.



In 2014, refined zinc usage was more balanced amongst the Balkan region's countries than that of lead. Usage in both Bulgaria and Romania was the highest of the group, at 16kt, in contrast with usage in Bosnia & Herzegovina, the lowest, at 2kt. In 2004 and between 2007 and 2010 Greece was the main refined zinc user in the Balkans. Last year, however, Greece usage ranked in forth, at no more than 6kt. Since 2007, Greece reduced its usage by almost 80%, in contrast to all the other countries that have in recent years shown some degree of recovery (even if minor in some cases) in zinc metal usage since their lowest period, generally between 2008 and 2010. However, with the exception of Bulgaria, each one of the countries included in the chart below used lower or similar amounts of refined zinc in 2014 than they did in 2003.

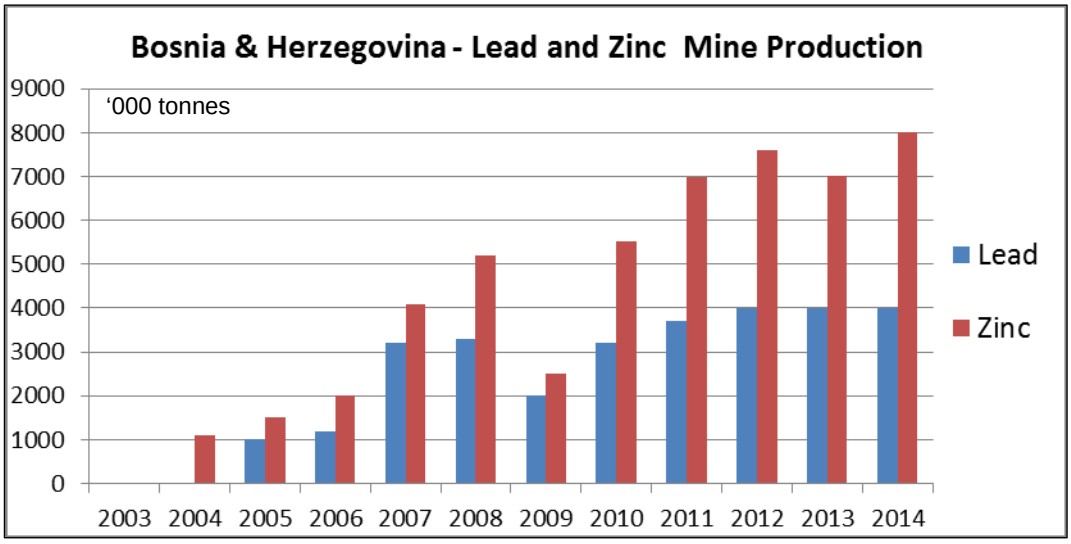


## Bosnia & Herzegovina

### Mine Production

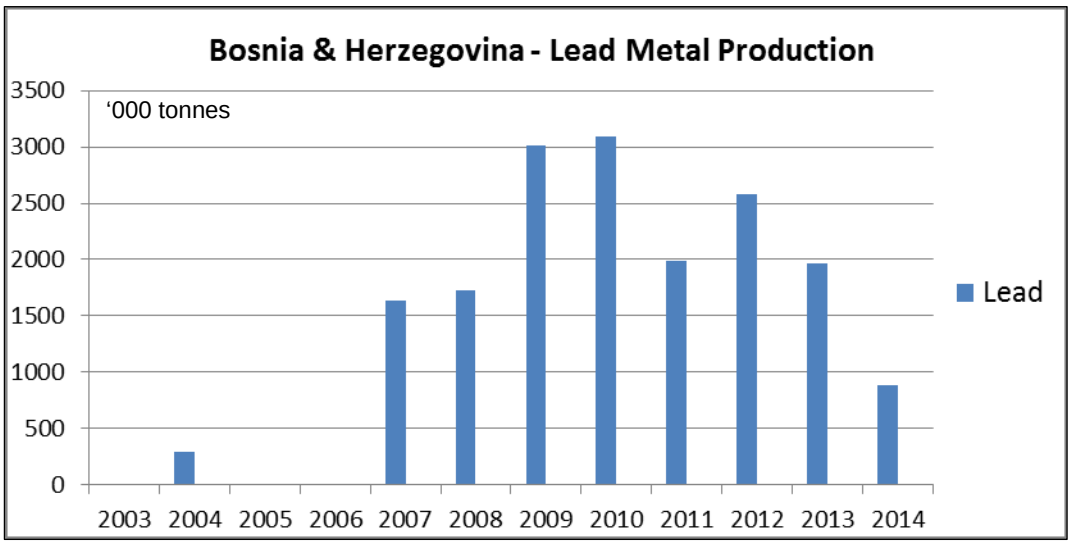
Production of lead concentrates in Bosnia is relatively modest when compared to its neighbours in the Balkans, accounting for less than 5% of the region's total output last year. Since 2003, growth in early years was interrupted only in 2009, stabilizing at around 4kt since 2011.

Zinc mine production is somewhat more relevant than that of lead, but in 2014 didn't exceed 8% of total production in the Balkans. After a fall of around 50% in 2009, it recovered quickly to an estimated yearly average production slightly above 7kt in recent years.



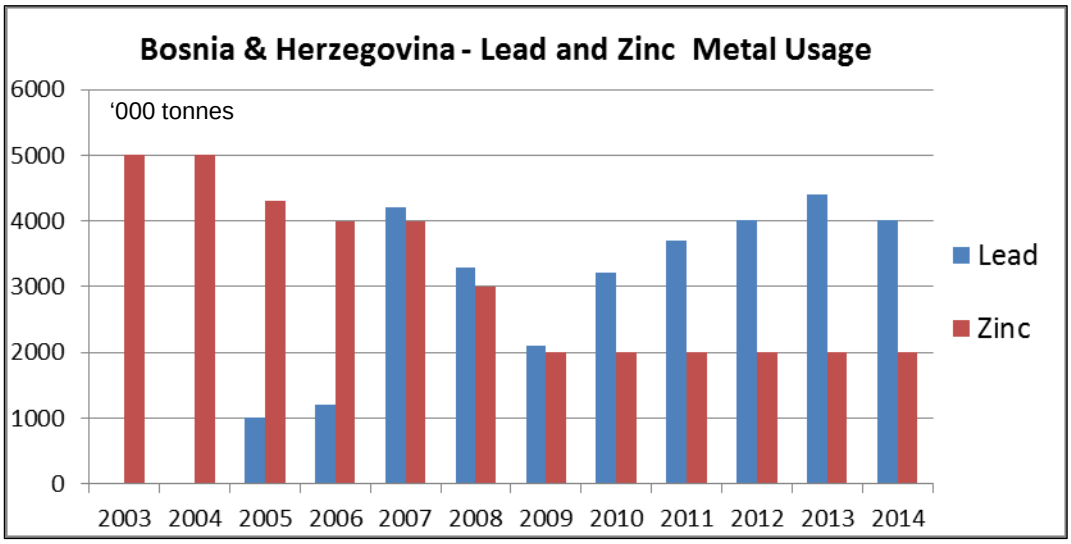

### Metal Production

Bosnia's metal production has not been significant when compared to other countries in the region, with less than 1kt of secondary metal produced in 2014, declining from its peak of around 3kt reached in 2009 and 2010.



**Metal Usage**

Not surprisingly, usage of both lead and zinc metal has been modest in Bosnia & Herzegovina. Refined lead has recovered from a low 2kt in 2009 to an average of 4kt/year in recent years. Zinc used fell from its peak in 2003 and 2004 to a stable 2kt per year since 2009.



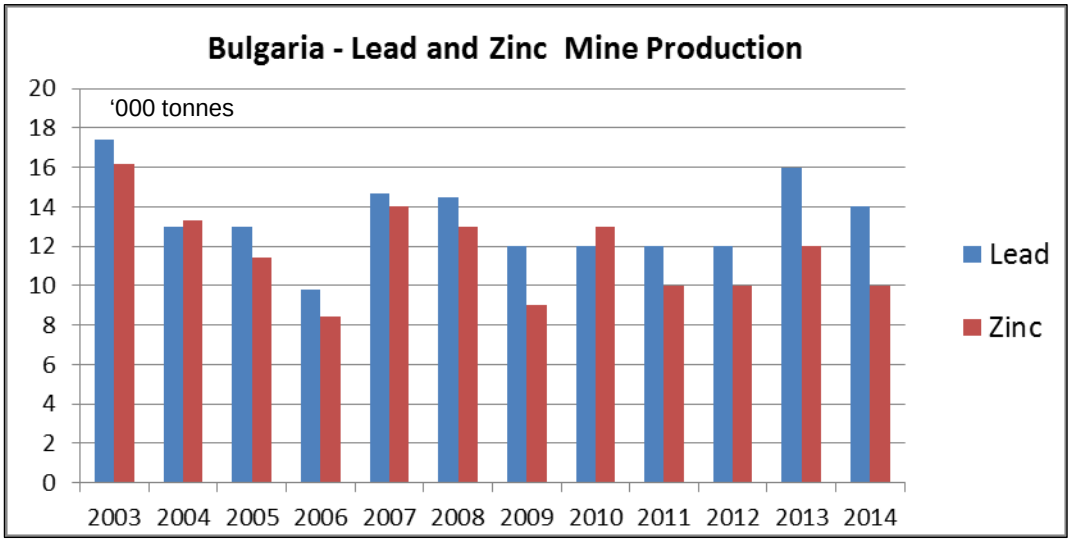
## Bulgaria

### Mine Production

Bulgaria plays a central role within the Balkan region in the lead and zinc markets, especially in the production of refined metal. In terms of concentrates production, it shows the unusual attribute (shared with FYRO Macedonia) of extracting from its 4 mines in operation higher quantities of lead concentrates than zinc concentrates.

Even if below the levels achieved in the past, its lead concentrates output was 14kt, almost 17% of total production in the Balkans, being the second largest producer. Since 2003, production has fallen until its lowest in 2006, followed by a strong recovery and further fall to a stable period, between 2009 and 2013, at around 12kt. The last two years of this series were positive, with production levelling above the 12 years' average.

The behaviour of zinc concentrates was similar to that of lead between 2003 and 2014, but production in 2013 and 2014 was slightly below the 12 years average. With lower levels than lead (2004 and 2010 were the exception), the production of zinc concentrates in Bulgaria is less relevant within the Balkans region: in 2014, output was 10kt, around one third of that in FYRO Macedonia.



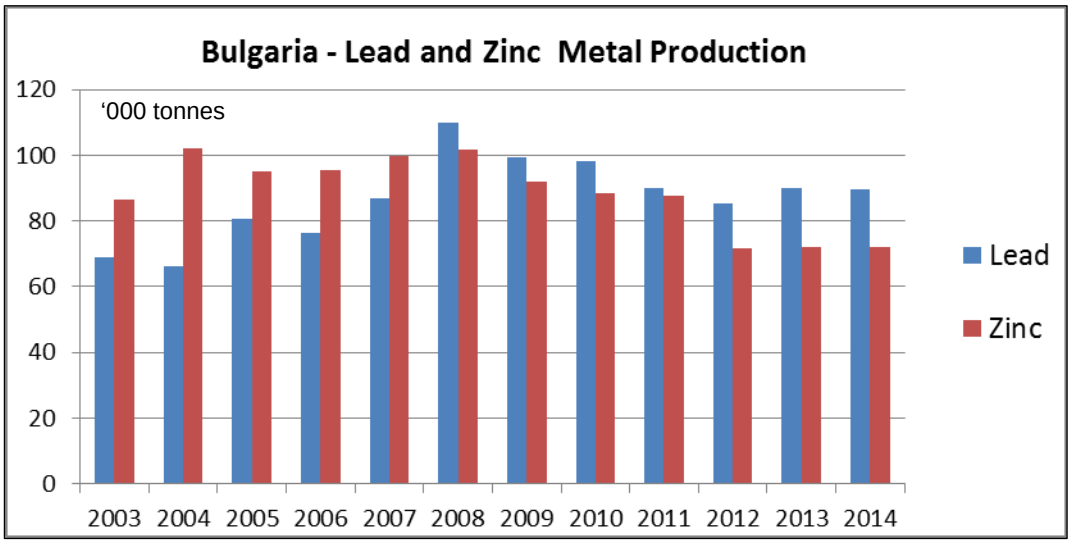

### Metal Production

Refined lead and zinc industry in Bulgaria has been dominated by one company, KCM AD, which as its main facilities located near the city of Plovdiv. In 2008 Elbat JSC and Monbat Recycling (also active in Romania and Serbia) added an extra 21kt to Bulgarian secondary lead refining capacity.

Refined output of both lead and zinc has been relatively stable in recent years, after a decline between 2008 (the peak of both series) and 2012, when the 30kt/year Kardjali Zinc Plant ceased activity. Although refined zinc output in 2014 was below its previous 12 years average, Bulgaria has been the only refined zinc producer in the Balkans for some years. It is also the biggest, by a comfortable margin, refined lead producer (64% of the total in 2014).

Lead metal has been refined in higher quantities than zinc since 2008 (by contrast, in 2004 refined lead output was less than 2 thirds of the zinc's) and a closer look reveals that its production was less affected by the economic downturn that began in 2008. This is the reason behind the fact that in 2014 Bulgaria refined almost 20kt more lead than zinc, of which production had been around 72kt in the

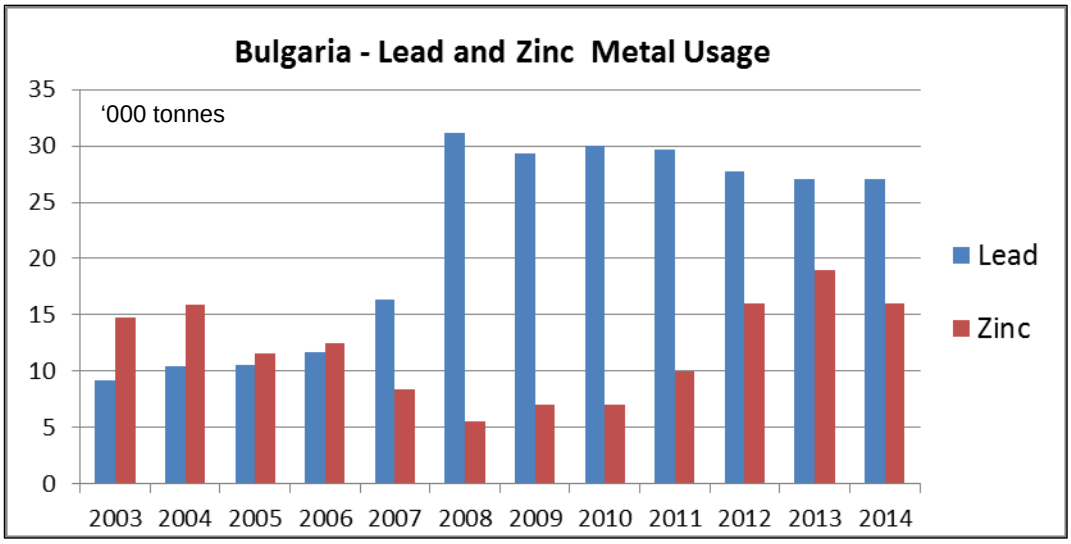
final three years of the period 2003-2014. Since 2003, Bulgarian authorities reported that an average of 28% of total refined lead and 11% of total refined zinc output each year was generated from secondary sources.




**Metal Usage**

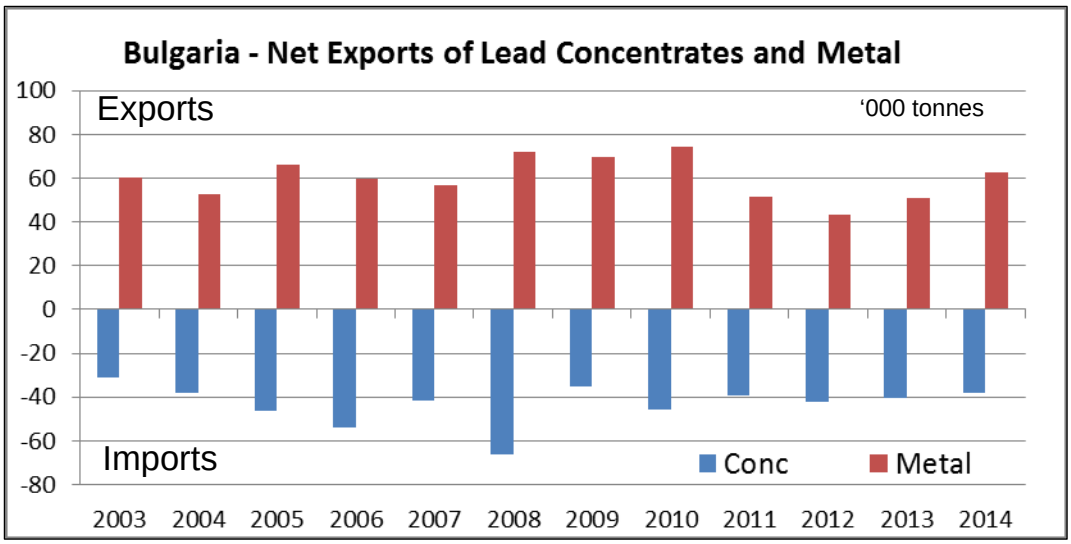
Usage of the two metals in Bulgaria suffered notable transformations between 2003 and 2014, and the behaviour of each one individually has been quite diverse. Until 2006, refined zinc usage was higher than that of lead, but in 2007 this relation was reversed by a large amount. Lead usage in 2008 jumped to 31kt, the highest level of the last twelve years (increasing almost 95% in one year). Usage of refined lead, mainly in the production of lead-acid batteries, was in 2008 almost six times larger than zinc's. Since then, however, lead usage has slowly declined and totalled 27kt in 2014. Despite this, Bulgaria was, together with Slovenia, the biggest lead user in the Balkans, accounting for 28% of total demand.

In 2013, refined zinc usage reached its peak at 19kt, more than three times higher than its low in 2008. In the last three years of the 2003-2014 series, zinc usage was well above the average, and accounted for 25% of total usage in the Balkans in 2014. An increase in steel galvanizing activity is the main reason for this trend; Bulgaria has hot dip galvanizing plants near Sofia and Plovdiv.

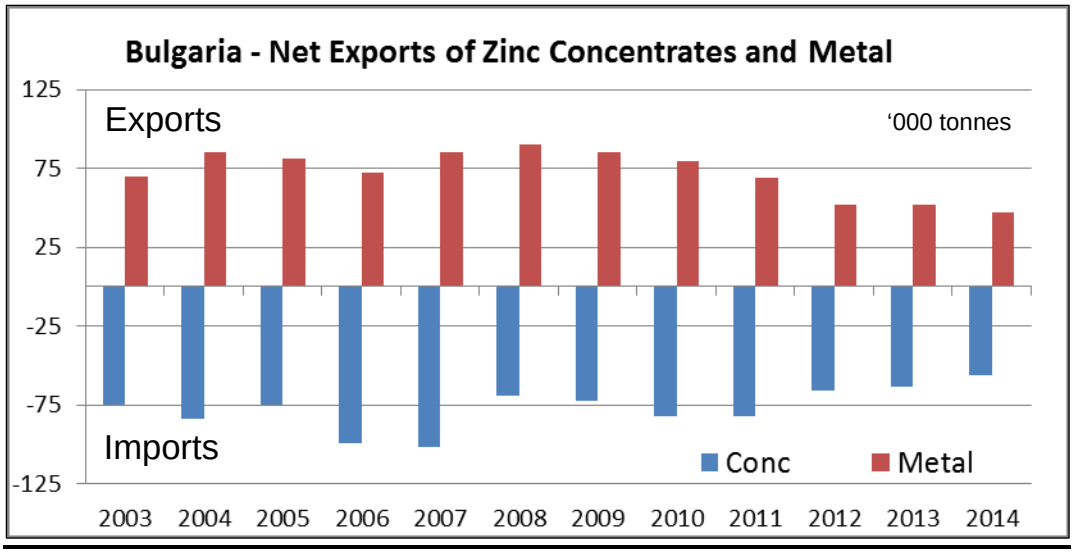


**Trade**

During the last twelve years, Bulgaria has been by a comfortable margin net exporter of refined lead and a net importer of lead concentrates. Between 2008 and 2010, exports of metal were above average, but fell in the following couple of years, to recover again in 2013 and 2014. Net imports of lead concentrates have remained stable in the last four years.



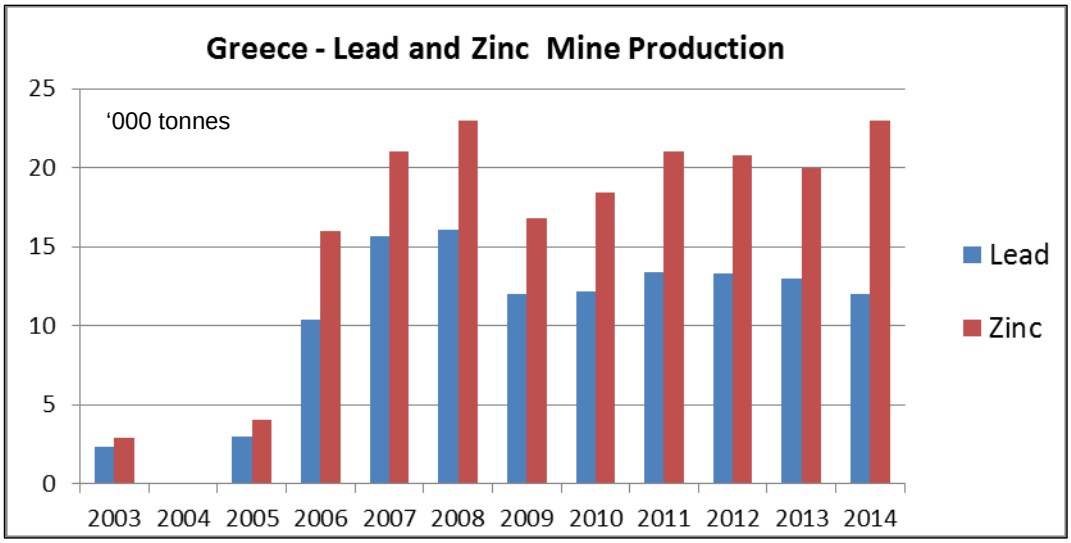

Regarding zinc, the scenario has been somewhat similar to lead's. Refined metal exports have been higher than imports by a comfortable margin, although this difference has slowly declined since 2008. In effect, net exports in 2014 were close to half of the net exports in 2008. Net imports of zinc concentrates have also declined in the last four years, but it is foreseeable that Bulgaria will continue to rely on foreign material to feed its refineries.



## Greece

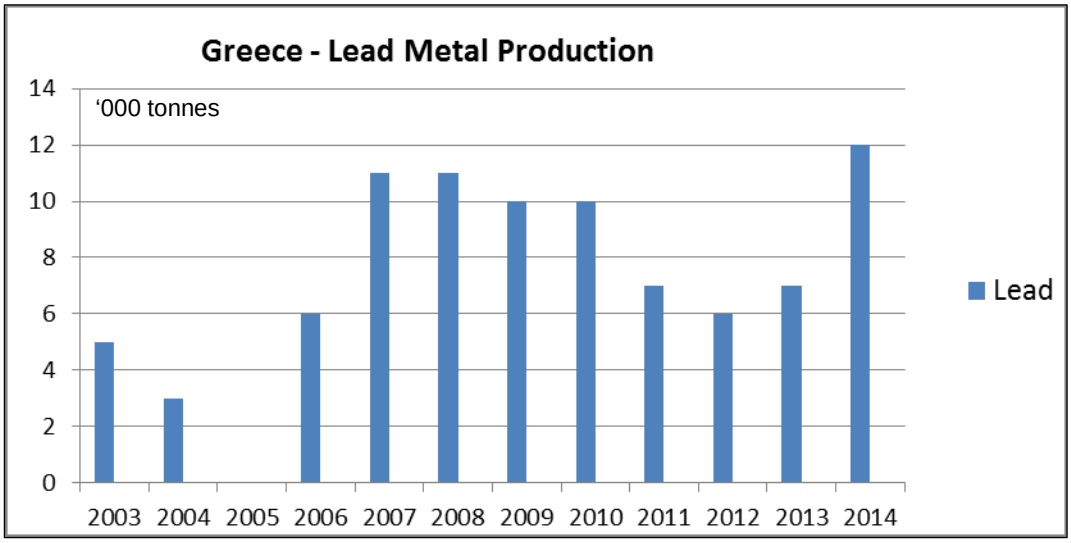
### Mine Production

Greece is now the second largest producer of zinc concentrates (and third largest of lead), accounting for almost one fourth of the Balkans total output in 2014. Operated by the Canadian company Eldorado Gold, the Kassandra mine resumed production in 2005 and generated 23kt of zinc last year (12kt of lead concentrates), a peak identical to the one achieved in 2008. Unlike what has been observed in zinc output, production of lead concentrates has been slowing down, even if not significantly, in the last three years of the series, increasing the differential compared to the highest levels reached in 2008 and 2009.




### Metal Production

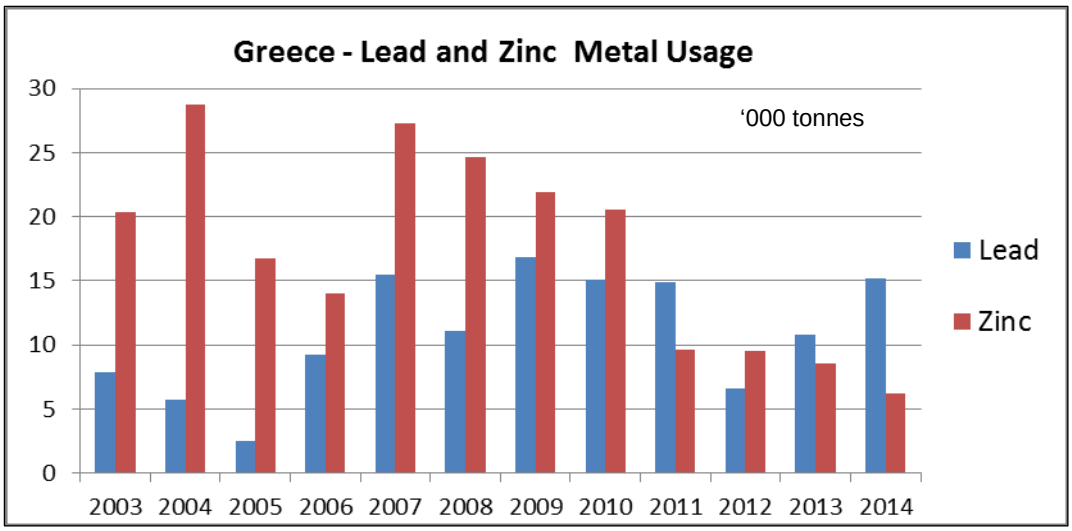
Greece's secondary refined lead production in 2014 increased by more than 70% when compared to previous year, reaching 12kt, its highest level since 2003. This recovery from the sluggish three precedent years is a direct result of the start-up of the Sunlight Recycling plant in the Rhodope region, placing Greece in the top three refined lead producers in the Balkans. However, mostly because Bulgaria's dominance in this area, Greek output was only 9% of the total lead metal generated in the Balkan region.



**Metal Usage**

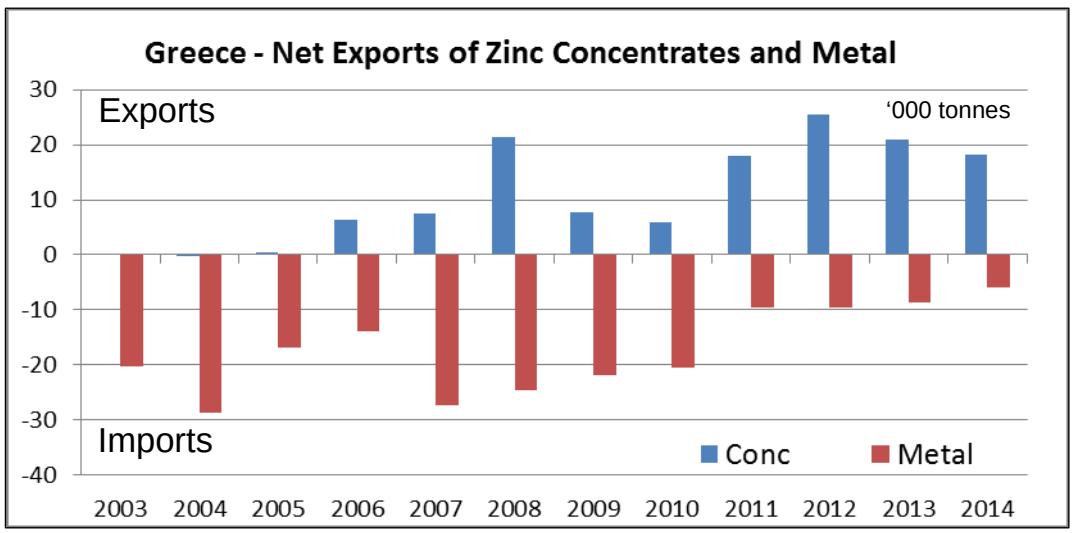
It is well known that the Greek economy has been going through severe difficulties in recent years. This has adversely affected steel galvanizing activity in the country (there is at least one hot dip galvanizer operating in Greece) and consequently resulted in a reduction in refined zinc usage. Falling since 2008, zinc usage in 2014 was no higher than 6.2kt, only 23% of what was used in 2007. Throughout the last seven years, the average annual fall of zinc usage exceeded 17%. This negative performance can also be highlighted if compared to Greece's neighbours in the Balkan region: in 2007, zinc usage in Greece was more than 30% of the total; last year it was less than 10%.

Refined lead usage, on the contrary, has increased in the last two years of the series to 15kt in 2014 (8.3% of the Balkan region). And although there was a reduction between 2009 and 2012, the falls were much more contained than what can be observed in the zinc market. It is interesting to observe that last year's refined lead usage was more than double that of zinc's. Before the economic crisis, for example in 2004, zinc usage – typically much more linked to the economic cycle – was five times higher than the usage of refined lead in Greece.




**Trade**

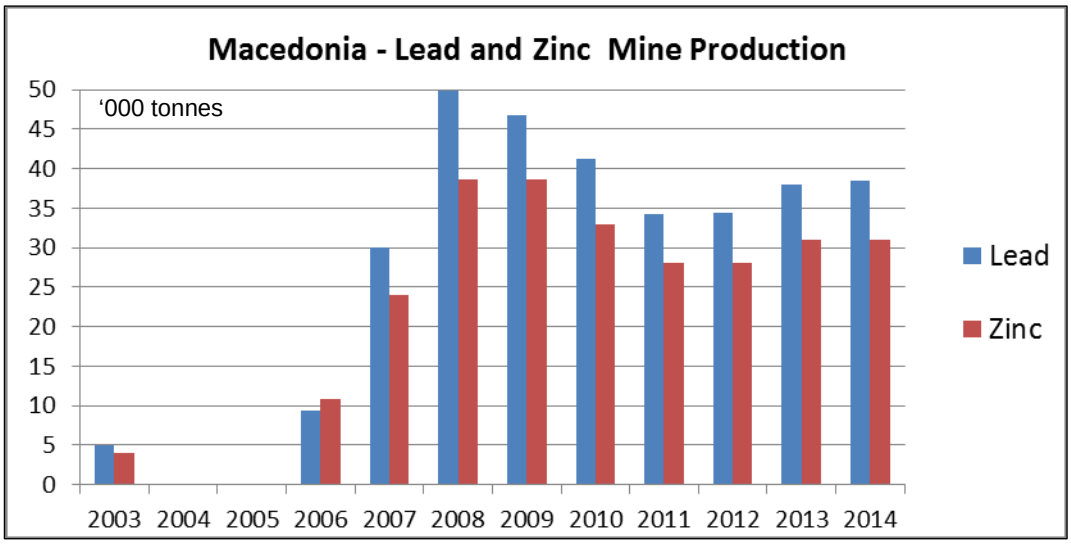
Greek external trade of zinc concentrates and metal illustrates the behaviour of these industries in recent years. On the one hand, it's a net exporter of concentrates, and exports have in the last four years remained above the average of the period between 2005 and 2014 due mainly to the restart of production in the Kassandra mine. On the other hand, net imports of refined zinc have declined sharply after 2007, as a consequence of the reduction in usage previously highlighted in this report.



## FYRO Macedonia

### Mine Production

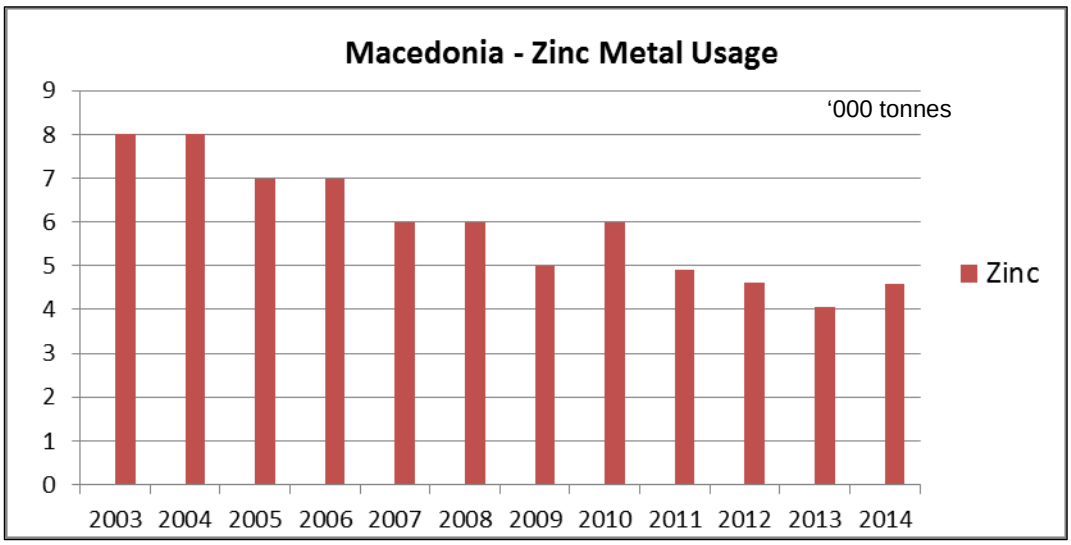
In 2003, production at the Sasa, Toranica and Zletovo mines was put on hold for a couple of years, and this reduced FYRO Macedonia's mine production to zero. However the reopening of Sasa mine in 2006, followed by the other two mines one year later, turned FYRO Macedonia into the major producer of lead and zinc concentrates in the Balkan region by a significant margin. Even if below the peak achieved in 2008, lead mine output in 2014 accounted for around 46% of the Balkan's total, well above that of the second largest producer, Bulgaria, which accounted for less than 17%. Zinc concentrates production is smaller and its importance when compared to the other countries in the Balkans has also been more limited: at 32.5kt in 2014, FYRO Macedonian production was 32% of the total, close to the 24% share of Greece, the second largest producer. After falling over the period 2008 to 2011, lead and zinc mine production in FYRO Macedonia has been recovering since 2012.




### Metal Usage

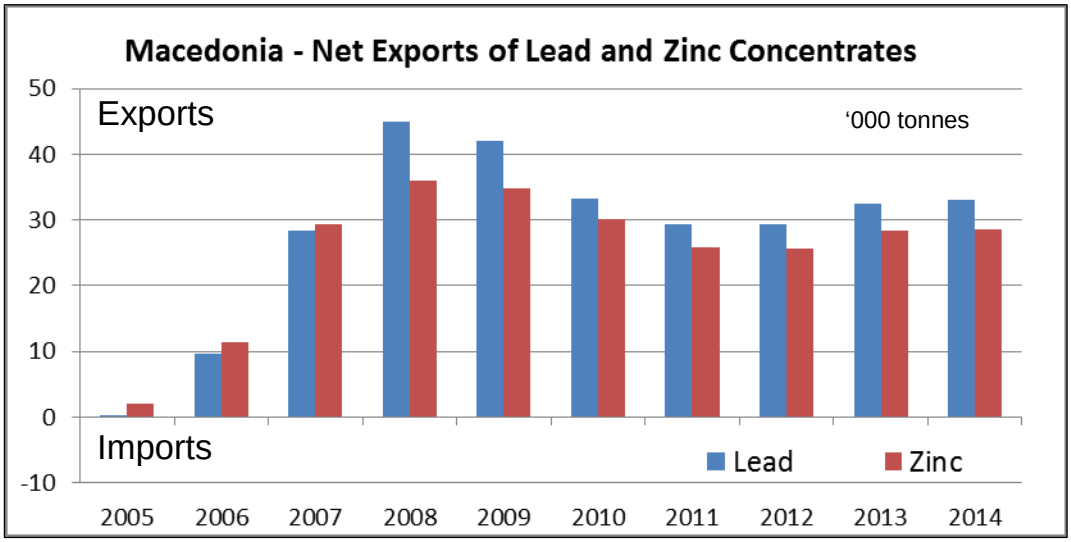
FYRO Macedonia lost its entire lead and zinc metal production capacity in 2003 with the closure of the 30kt/year lead and 66kt/year zinc plants at Tito Veles.

In terms of zinc usage, it has declined from 8kt in 2003 to 4kt in 2013. With one continuous hot dip galvanizing plant operating since 1972 in Skopje, FYRO Macedonian usage of refined zinc recovered slightly in 2014 but remained unimportant relative to Balkans' usage at 7% of the total.



**Trade**

FYRO Macedonian trade of lead and zinc concentrates is strongly correlated to its production. A clear net exporter since its mines reopened, FYRO Macedonia's exports peaked in 2008 and 2009, decreasing in the following years until 2011, to slowly recover up to our most recent year in analysis, 2014. Exports of lead concentrates have been slightly higher than zinc's, at 33kt and 28.6kt in 2014.

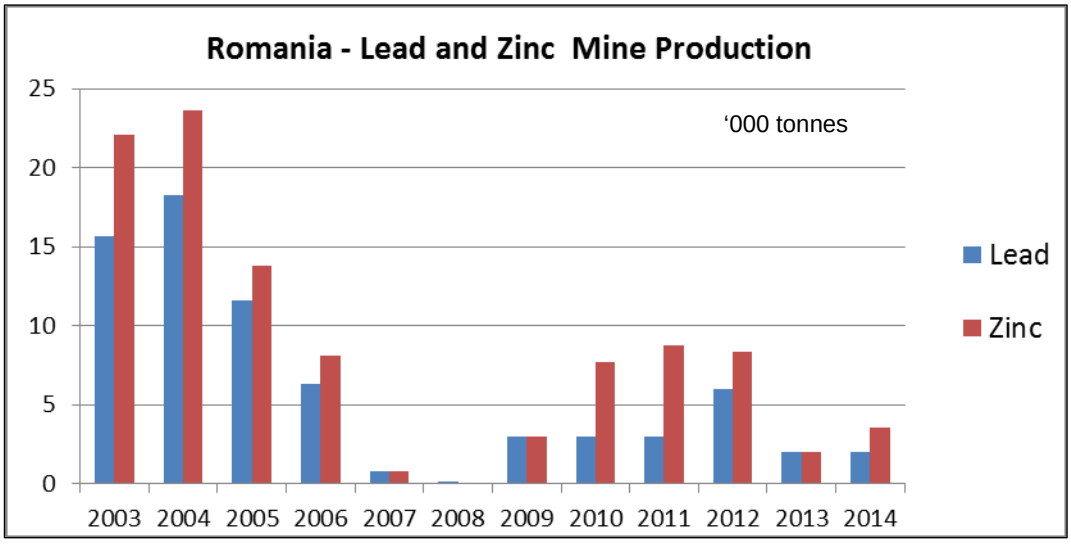


## Romania

### Mine Production

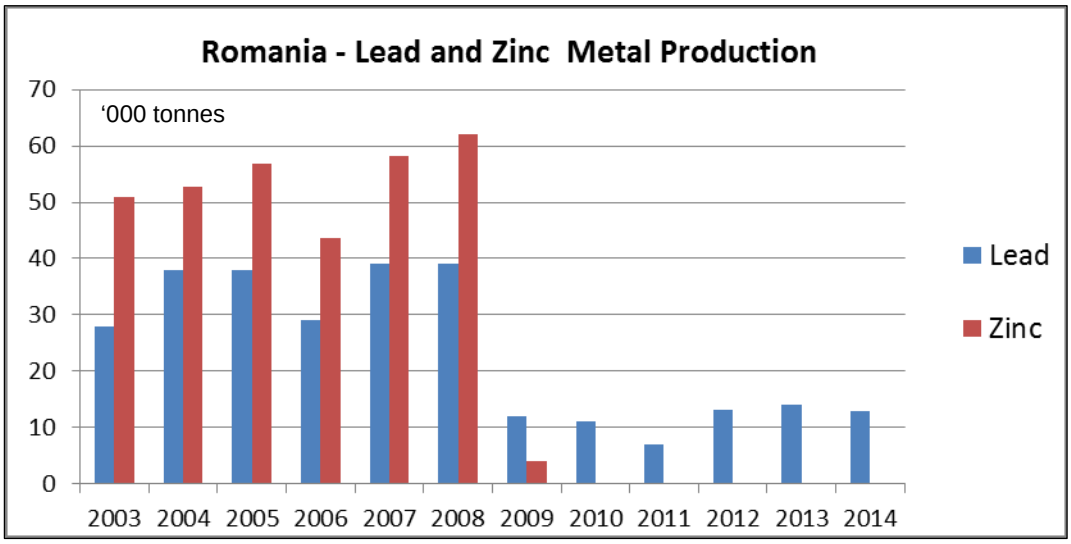
When compared to its neighbour countries, Romania followed in recent years a very singular path regarding its lead and zinc industries. The key word to describe it is disinvestment. Romania was once a very significant player in the region, both in mining – it was the top producer of lead concentrates in 2004 and of zinc concentrates between 2003 and 2005 – and in metal. However, its weight in these markets dramatically dropped in recent years, becoming almost irrelevant when compared to the other countries in the region.

In 2004, Romania's zinc concentrates output reached a peak of almost 24kt, the highest in the Balkans by a substantial margin. In the same year, lead mine production peaked at 18.3kt, also above all the other countries in the region. After this, production fell dramatically to close to nill in 2008. In the subsequent year, production restarted, and although at much lower levels than before, some activity could be observed before 2013, when a new sharp reduction occurred. Last year, Romanian output of both lead and zinc concentrates accounted for less than 3% of the total regional production.



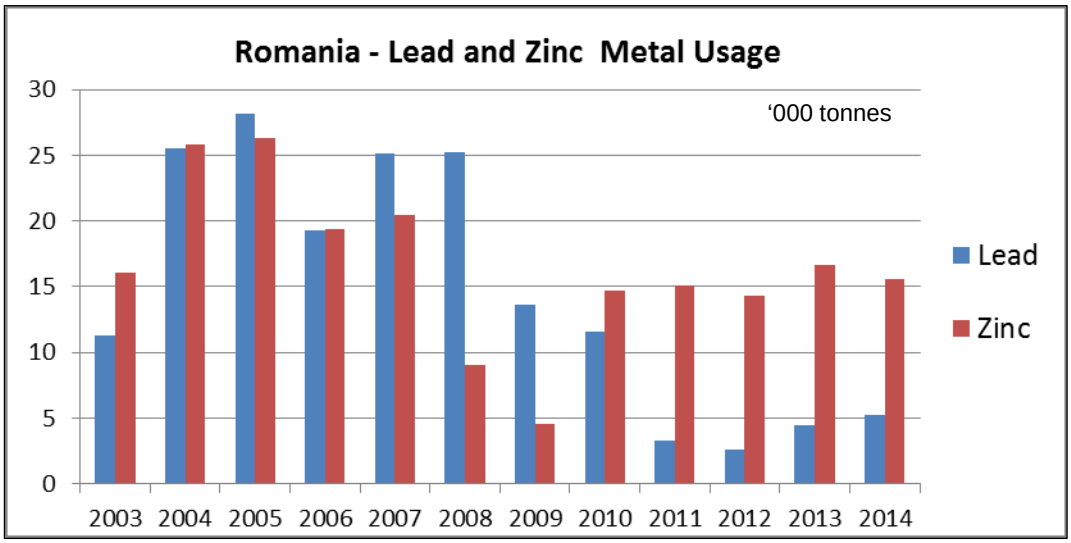
**Metal Production**

Romania was a relatively strong producer (even if below Bulgaria) of refined zinc until 2009, when a large but old 66kt/year capacity refinery near Copsa Mica ceased production. That was also a crucial year for the refining lead industry, since its output levels dropped to a third of the previous six years average, as a result of the closure of the 42kt/ year capacity plant located in the same region. Since then, refined lead output has remained relatively low at a 12kt yearly average. Nevertheless, a modest increase in production could be observed after the opening of the 22kt/year capacity Monbat Recycling plant in 2012, which recovers lead from used batteries.



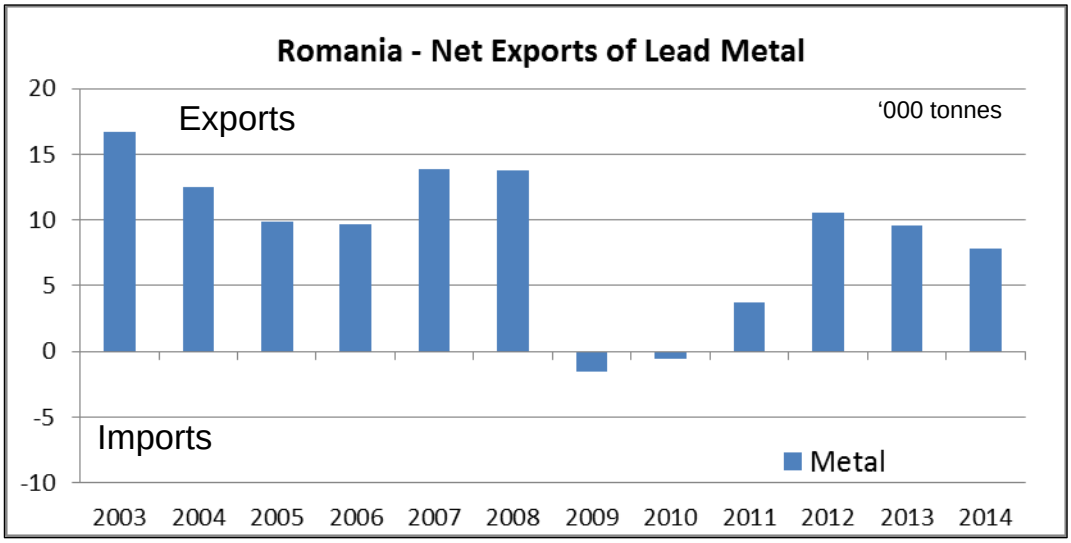
**Metal Usage**

The usage of lead and zinc metals in Romania within the last 12 years can be divided in two periods: before 2009, with substantially higher levels, and after that year, with a much lower yearly usage average. But there are differences between the two metals: refined lead usage, the highest in the Balkans region between 2004 and 2007, peaked in 2005 at more than 28kt (42% of total usage in the Balkans). In 2009, lead usage fell by 46%, and continued to collapse until 2012, reaching a low of 2.6kt (less than one tenth of what had been used seven years before). Since then, it recovered modestly, to 5.3kt in 2014 (5% of total in the Balkans). Zinc usage was also severely affected by the 2009 economic crisis, falling 78% between 2007 and that year. The highest zinc user in the Balkans in 2005 and 2006, Romania accounted for less than 8% of the total in the Balkan region. However, zinc usage has recovered – unlike lead – after this troubled period. Between 2010 and 2014, it has been relatively stable, averaging just over 15kt per year. Romania has one hot dip galvanizing line in Galati capable of using 8kt of refined zinc per year, and after 2009 it regained its relevance in the region in terms of zinc usage, being the second largest in 2014.

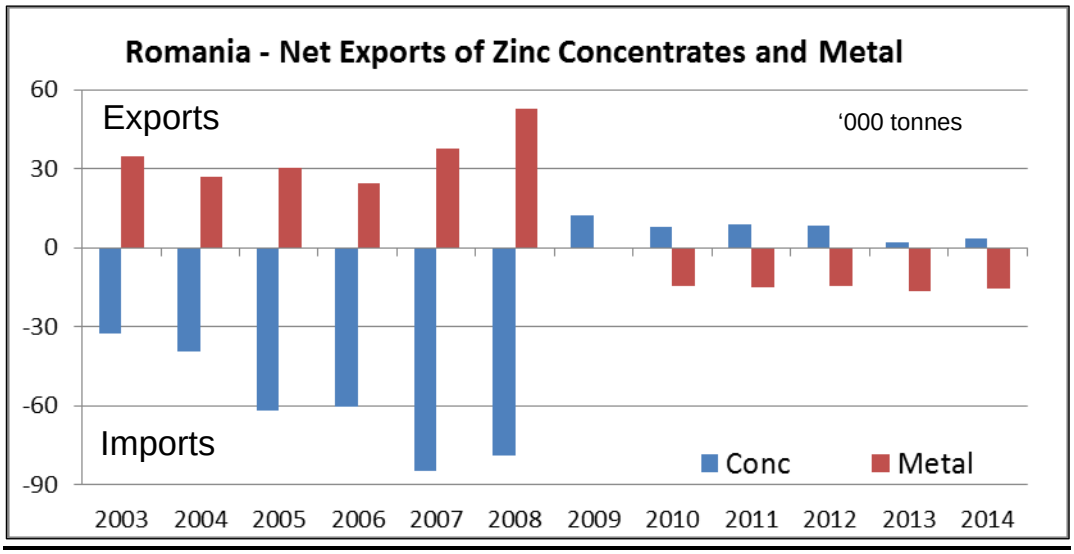



**Trade**

Romania was a net exporter of lead metal until 2008. In the subsequent two years, and in line with the big drop in production, imports and exports were almost balanced. In recent years net exports showed some recovery, even if production has remained low, helped by lower levels of internal usage.



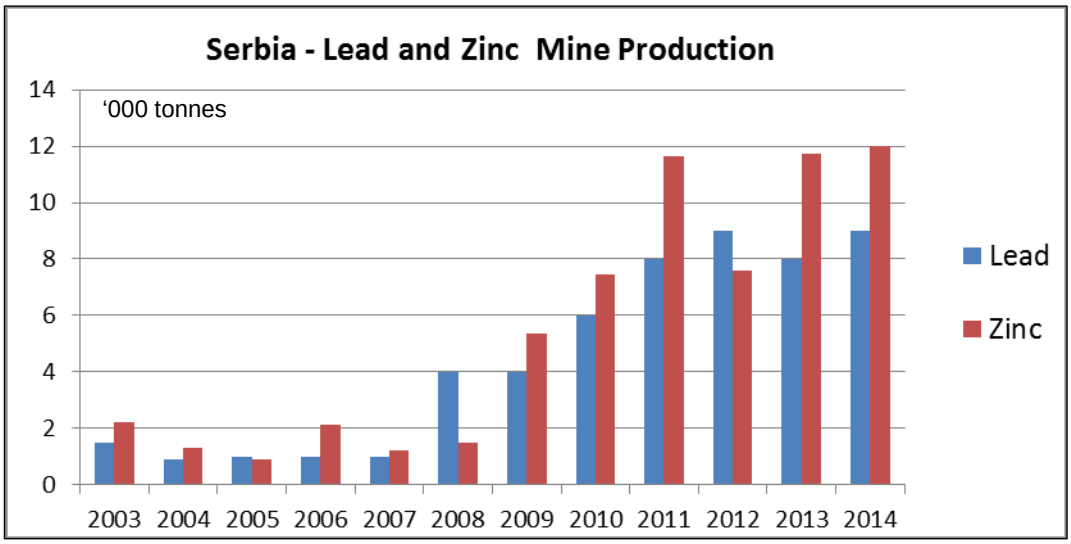
Romanian net imports of zinc concentrates until 2008 clearly reflect zinc metal production, which remained high until that year and was exclusively fed by primary sources. It also shows that zinc concentrates produced internally were not sufficient to match demand. In terms of metal trade, again the closure of the zinc refinery was a key factor, since it forced Romania to becoming a net importer, after a number of years during which exports had exceeded imports by a comfortable margin.



## Serbia

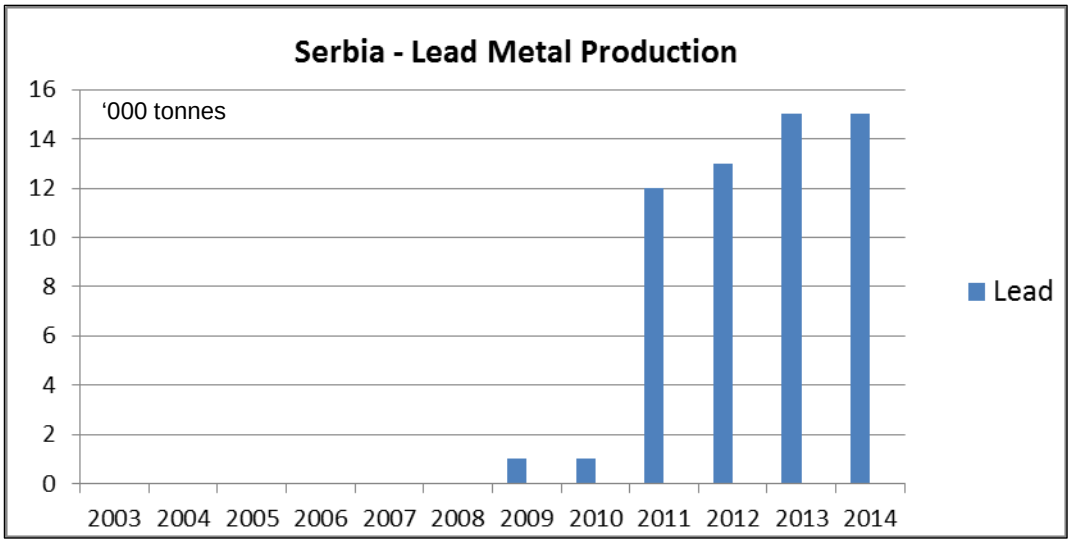
### Mine Production

After some lethargic years (2003-2007) where lead and zinc concentrates production in Serbia remained insignificant, the scenario changed positively in 2008. Between 2007 and 2014, lead mine production increased by 8kt and zinc by 11kt, both reaching output peaks last year. Even if in absolute terms these amounts might look modest, the chart below shows that there was in recent years a shift in this sector in Serbia. In fact, this country was in 2014 the third largest zinc mine producer of the Balkans (fourth in lead) accounting for almost 13% of total output (11% in lead).



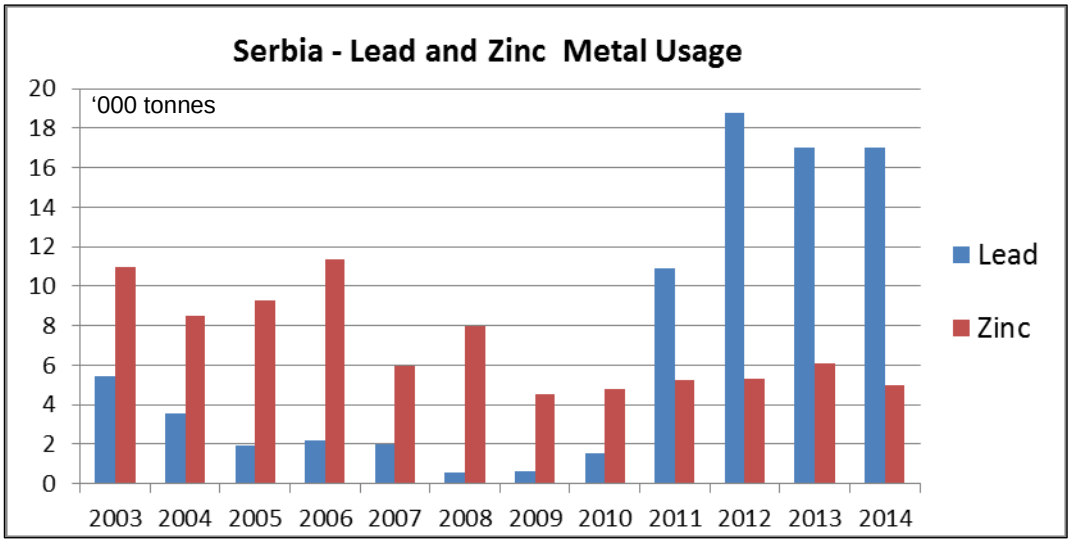

### Metal Production

In 2011 Monbat Recycling, an active player in lead recycling industry in the Balkans, opened a 16kt/ year capacity plant in Serbia. This has turned Serbia into the second-largest refined lead producer in the region, although still well below (10.5% of the total) the largest producer, Bulgaria. Serbia is believed to be producing a small amount of primary lead, in addition to the Monbat Recycling output. Total production in 2014 was 15kt.



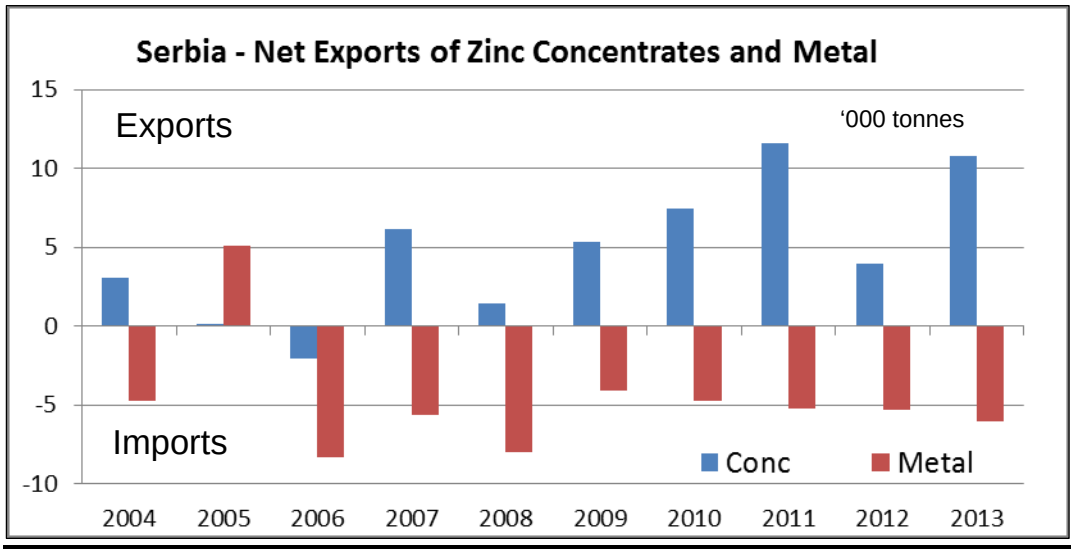
**Metal Usage**

Refined lead usage in Serbia was relatively modest before 2010. After slowly declining to close to zero in 2008, it jumped to 11kt in 2011, and to close to 19kt in the following year, reaching the peak of this series. Lead usage has subsequently declined by a small amount, but in 2014 Serbia was the third largest user of refined lead in the Balkans, accounted for almost 18% of the total. Zinc metal usage was bigger than lead's until 2010, peaking just above 11kt in 2006, but it has declined throughout the subsequent years. Average annual usage in the last six years was around 5kt, lower than previous six years average of 9kt. When compared to other countries in the Balkans, zinc usage was relatively minor, in line with that in FYRO Macedonia.




**Trade**

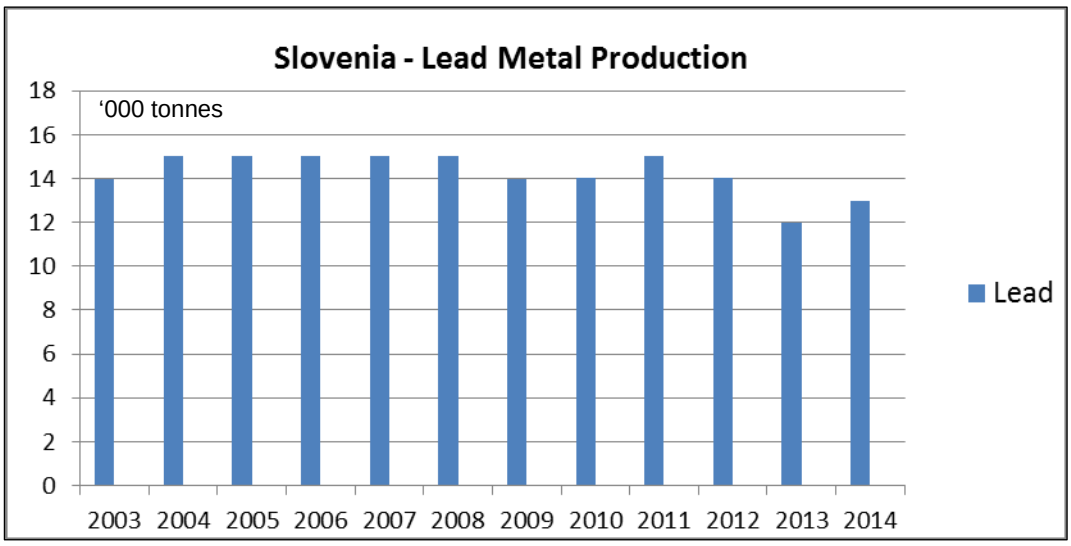
Serbia has been in the last seven years a net exporter of zinc concentrates, which is in accordance to its increasing mine output. The 2012 level of net exports was, however, quite low but it recovered the following year to just above 10kt. On the contrary, since 2006 Serbian demand for refined zinc has been fed by imported material. Net imports decreased to a low reached in 2009, but have partially recovered since then.



## Slovenia

### Metal Production

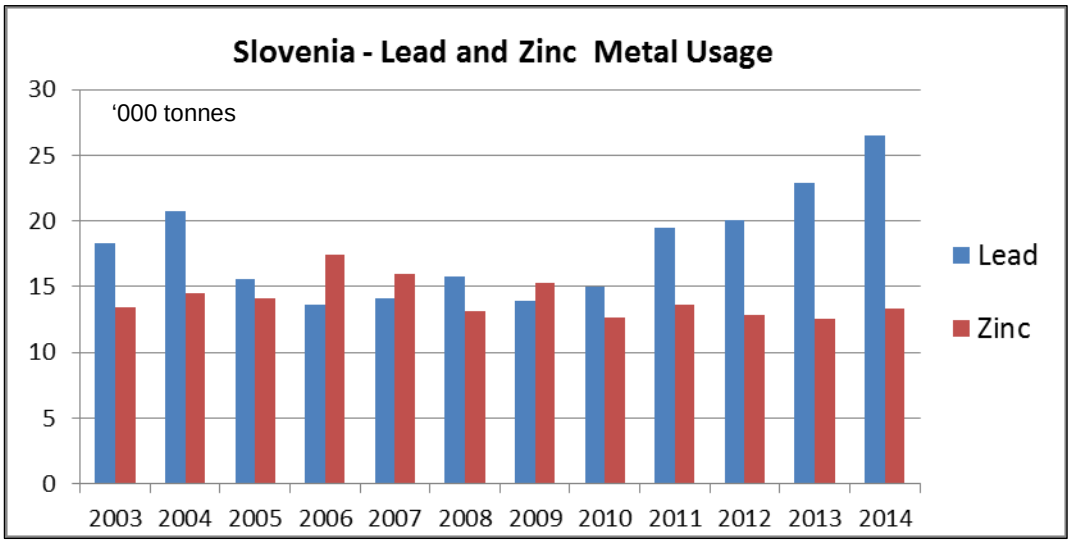
Slovenia maintained a very stable level of secondary lead metal output between 2003 and 2011, at around 14kt. After that, there was a moderate reduction, but in 2014 production partially recovered to around 13kt, identical to that of Greece and Romania and just under Serbia's.




### Metal Usage

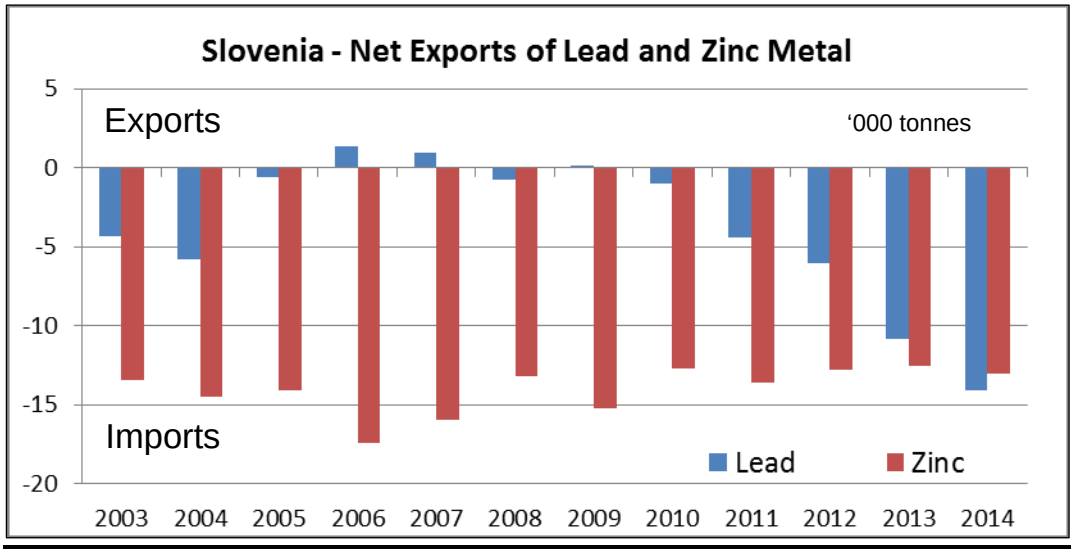
Refined lead usage in Slovenia rose from 15kt in 2010 to almost 27kt last year, at an average annual growth rate of 15.7%. This impressive trend places Slovenia as the top lead metal user in the Balkans in 2014, together with Bulgaria, accounting for almost 28% of the total.

Zinc usage has been slowly declining from its 17.4kt peak in 2006 (13.3kt in 2014) but last year was still the third largest refined zinc user in the Balkans.



**Trade**

Slovenia's trade of lead and zinc metal shows, on the one hand that its refined zinc usage totally relies on external purchases, since there is no internal production, and on the other hand that lead usage has been growing fast in recent years. However, despite a relatively steady level of secondary lead production, Slovenia has become a strong net importer of this metal, with net imports reaching 14kt in 2014.



# V. Nickel in the Balkan Region

## Nickel in the Balkan Region

In the Balkans nickel deposits are of lateritic type due to the occurrence of ophiolitic massives.

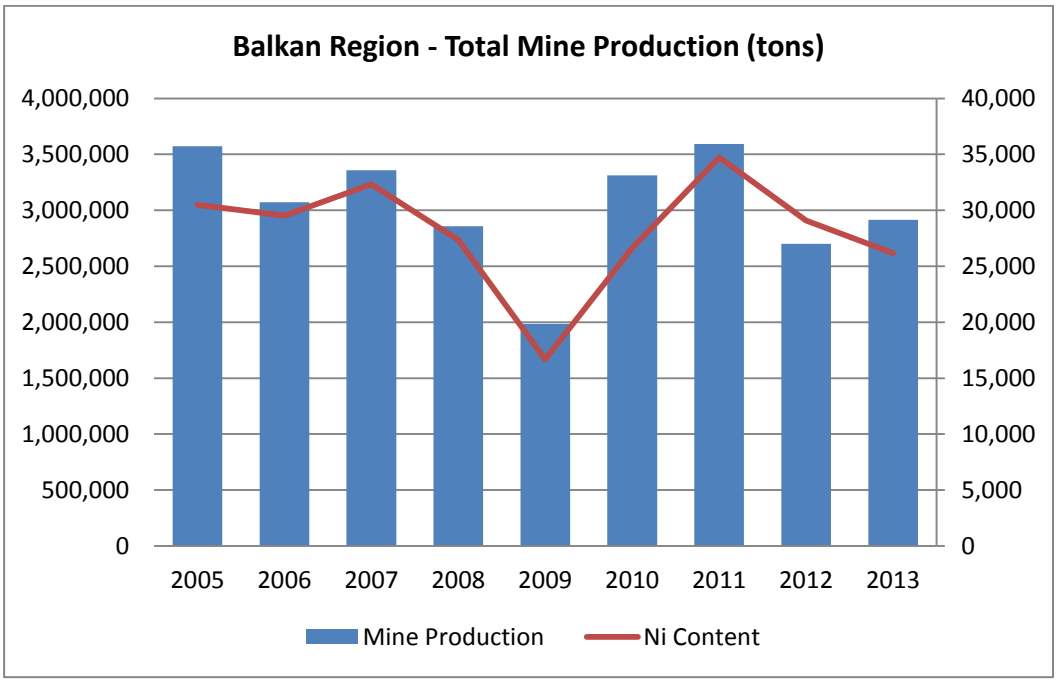
The Eastern Mediterranean represents one of the regions with the world's highest concentration of ophiolitic complexes. The process leading to the overthrust of ophiolite complexes on continental crust are tied to tectonical emplacement of ocean crust during the collision of ocean and continental plates. The collision process during the closure of the Paleotethys started in the early stages of the Mesozoic era (Middle Triassic – Cretaceous). The result was the forming of back arc basins and calc-alkaline insular arc.

Laterisation is a chemical weathering process whereby atmospheric, groundwater and biologic processes interact through exposed rock surfaces and fractures in the bedrock to decompose the primary rock minerals and form more stable mineral phases in the weathering zone. There are significant variations between different laterite profiles and within each laterite profile. The formation of each laterite deposit is influenced by the parent bedrock, the degree of serpentiniation, the local bedrock structures, topography and climate.

It is possible to identify nickel bearing deposits of sedimentary type formed by the chemical weathering of laterites and transportation of these products and "in situ" lateritic deposits overlying their parent rocks.

### Mine Production

Currently mine nickel production is concentrated in four countries (Albania, Greece, Serbia (Kosovo) and FY Republic of Macedonia) with Greece representing about 80 percent of the total. Total nickel mine production (in nickel content) peaked in 2011 at 34,700 tons and bottom out at 16,700 tons in 2009.



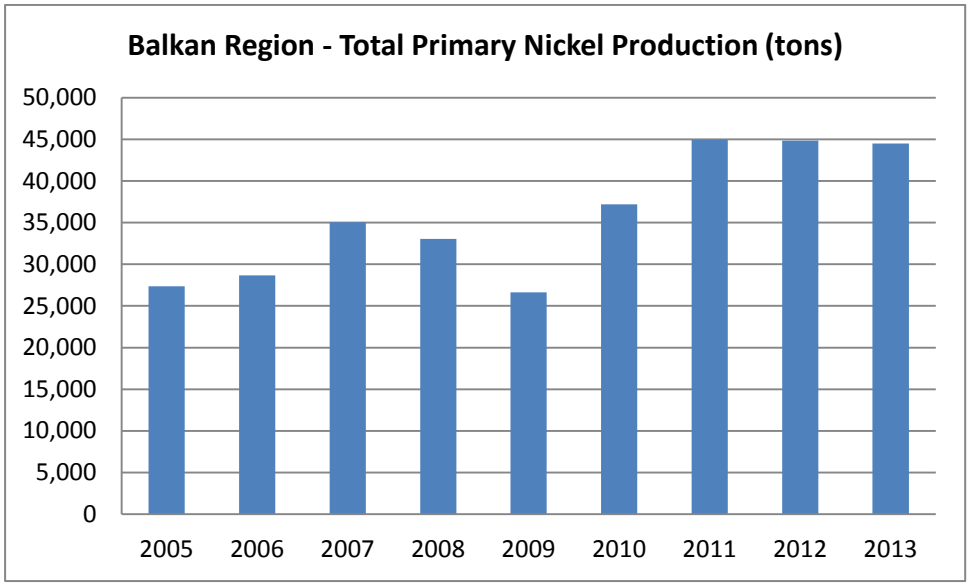

*Source: INSG, LARCO and others*

### Primary Nickel Production

In terms of primary nickel production there are three operating ferronickel producing plants in the area located one in Greece (Larymna) one in Serbia-Kosovo (NewCo Ferronikeli) and one in FYRO Macedonia (FENI Industries).

The Larymna plant is owned by LARCO, one of the most important producers in the world, while NewCo Ferronikeli and FENI Industries are subsidiaries of Cunico Resources NV a multinational mining and metals group engaged in exploration, extraction and refinement of nickel ore.

Total primary nickel production reached in 2013 an estimated 44,479 tons growing in the period 2005-2013 by a compound annual growth rate of 5.5%.



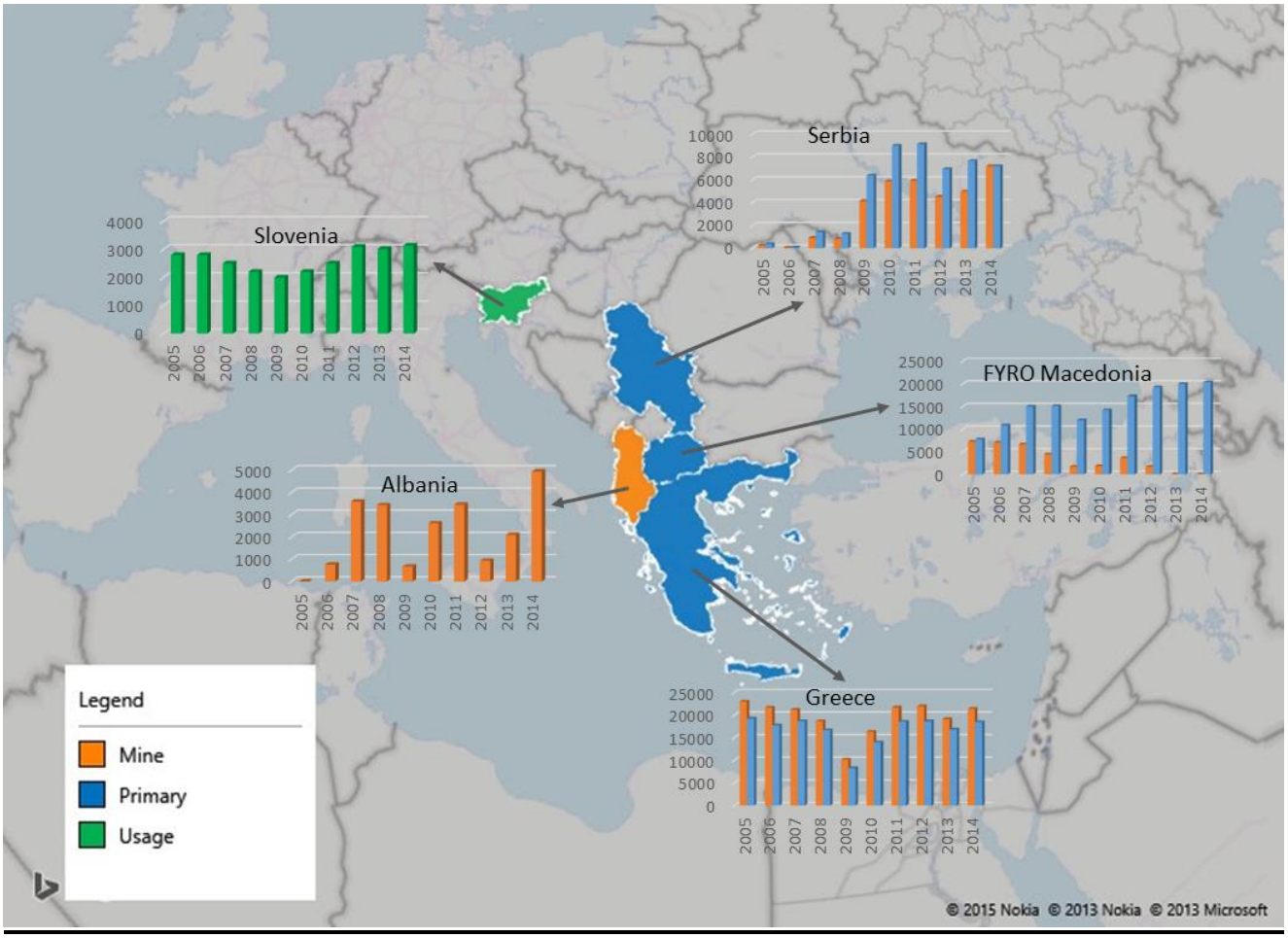

*Source: INSG, LARCO and others*

**Primary Nickel Usage**

Primary nickel usage in the Balkans has been affected by the closures of various facilities due to the passage from a centralised to a more privatised economy and also from the fact that modernization and economic growth has lagged behind that of Western Europe and even the rest of eastern Europe were other countries such as Poland and the Czech Republic have considerably more advanced economies.

Nowadays the only country with a significant primary nickel usage is Slovenia, an estimated 3,900 tons in 2014, due to the presence of SIJ (Slovenka Industrija Jekla) Group which include the main stainless steel and tool steel producers in the country: Acroni and Metal Ravne.

The map below summarizes the nickel market in the Balkan Region by country.




## ALBANIA

### Nickel Reserves and Resources

The formations of the old weathering crust and the iron-nickel and nickel-silicates deposits are connected with ultrabasic rocks of Mirdita tectonic zone (Albanides). They are formed from the weathering process of the ultrabasic rocks.

Main deposits are located in three regions:

- **Devoll** (Bilishti, Bitincka, etc.). It is the biggest deposit explored in Albania. This region contains iron-nickel and nickel-silicate deposits of Bitincka and Kapshtica and also occurrences of Shkoza and Verrnik. It is located in the north of Bilishti town, near to Bitincka village. It is linked by 2 km road with the national road Korca-Bilisht-Kapshtica. The deposit seizes an area of 8.4 km², by length of 5.6 km and width of 1.5 km. Bitincka deposit is placed in types of weathering crust (lateritic) remained in situ, with a very long extension of iron-nickel and nickel-silicate ores. The ore body is placed among the ultrabasic rocks as floor and sedimentary rocks as roof.

- **Has-Kukës-Lurë** (Mamez, Trull Surroj, Nome). The region includes the north-east part of the tectonic zone of Mirdita (Albanides) of spreading of weathering crust products (laterites). The area is relatively big and it is located in the north of Albania about 20-50 km south west of the town of Kukes. The deposits could be exploited by open-pit mining.

- **Librazhd-Pogradec** (Guri Kuq, Cervenaka, etc.). This region has very large reserves of iron-nickel ores spread in two belts:

1. **North-East Wing.** On surface the iron-nickel ore body appears interrupted by ultrabasic rocks with carbonate deposits which extend for more than 30 km from the Northeast outcrop of Buzgara deposit and continuing to the south with deposits of North Bushtrica, Central Bushtrica, Upper Bushtrica, Skroska, Xixillas, and others.

2. **North-West Wing.** Part of this wing is formed by the important deposit of Liqeni i Kuq (Red lake) and Xhumaga, two small deposits Berzeshta, Debrova and many occurrences. The ore body is located between two carbonic facies as floor and roof. Its length in Liqeni i Kuq is 1700 m and in Xhumaga 2800 m. Ore body thickness ranges from 5 m to 40 m in Xhumanga and 0.36-6.9 m in Liqeni i Kuq.

   Total nickel ore reserves are estimated at 325.8 million tonnes of which 222.2 million tonnes of iron-nickel and 103.6 million tonnes of nickel-silicate.

**Nickel Mineral Reserves by Region**

| **Region** | **Quantity 000/t** | **Fe avg %** | **Ni avg %** | **SiO2 avg %** | **Co avg %** |
|---|---|---|---|---|---|
| **Devoll** | | | | | |
| *Total Ni-Si* | 50,826 | *13.50* | *1.32* | *37.80* | *0.05* |
| *Total Fe-Ni* | 53,960 | *43.50* | *1.10* | *10.70* | *0.08* |
| **Has-Kukës-Lurë** | | | | | |
| *Total Ni-Si* | 52,820 | *18.2-22.2* | *0.97-1.20* | *39.4-43.3* | *0.04-0.06* |
| *Total Fe-Ni* | 27,509 | *33.3-43.3* | *0.85-1.10* | *12.9-26.7* | *0.05-0.06* |
| **Librazhd-Pogradec** | | | | | |
| *Total Fe-Ni*<br>*of which:*<br>*North East Wing*<br>*North West Wing* | 156,583<br><br>119,700<br>36,883 | <br><br>*38.5-48.2*<br>*27.9-39.4* | <br><br>*0.80-1.02*<br>*0.58-0.85* | <br><br>*4.8-17.0*<br>*16.2-33.6* | <br><br>*0.06-0.08*<br>*0.05-0.08* |
| ***Total Ni-Si*** | ***~103,646*** | | | | |
| ***Total Fe-Ni*** | ***~222,152*** | | | | |
| ***Total*** | ***~325,798*** | | | | |

*Source: AKBN and others*

**Main nickel deposits**

***<u>Devoll Region</u>***

**a) <u>Bitincka Mine</u>**

Bitincka mine has opened in 1982 and it has been in operation up to 1992. Proved reserves are about 36.3 million tons. The reserves of Fe-Ni are about 21 million tons (Ni 1.03%, Fe 40%, SiO2 9.61%), while the reserves of Ni-Si are about 15.3 million tons (Ni 1.21%, Fe 17.5%, SiO2 36.8% and Co 0.03%).

**b) <u>Kokogllave Mine</u>**

Kokogllave mine is located about 1 km far from Bilishti. The mine has a strike 1km in the direction south-north and 0.8 km in the dip of west-east direction of Kokogllava deposit. Proved reserves are

about 31.7 million tons. The reserves of Fe-Ni are about 15.3 million tons (Ni 1.13%, Fe 42.6%, SiO2 9.07%, Co 0.08%), while the reserves of Ni-Si are about 16.4 million tons ( Ni 1.32%, Fe 14.7%, SiO2 36.59% and Co 0.04%).

**c) Strane Mine**

Strane Mine is located 2 km east of the town of Bilishti. The deposit has a strike about 1 km in the south-north direction and 0.2 km in dip west-east direction. Total proved reserved are about 9.5 million tons. The reserves of Fe-Ni are about 3.1 million tons (Ni 1.11%, Fe 44.4%, SiO2 10.4%), while reserves of Ni-Si are about 6.4 million tons (Ni 1.27%, Fe 12.8%, SiO2 37.65%).

**d) Kapshtice Mine**

Kapshtice Mine is located 3km east from the town of Bilishti. The deposit has a strike about 1 km in the south-north direction and 1 km in dip west-east direction. Total proved reserves are about 24.7 million tons. The reserves of Fe-Ni are about 12.6 million tons (Ni 1.25%, Fe 42.5%, SiO2 9.77%), while the reserves of Ni-Si are about 12.1 million tons (Ni 1.21%, Fe 18.7%, SiO2 29.75%).

| No. | Deposit | Geologic Reserves of **Iron-Nickel** Fe-Ni | | | | | | Geologic Reserves of **Nickel-Silicate** Ni-Si | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity million tons | Quality - % | | | | | Quantity million tons | Quality - % | | | | |
| | | | Fe | Ni | SiO2 | Co | MgO | | Fe | Ni | SiO2 | Co | MgO |
| **1** | **Bitincke** | **21** | **40,5** | **1,03** | **9,61** | | | **15,3** | **17,5** | **1,21** | **36,8** | **0.03** | **15,8** |
| 2 | Kokogllave | 15,3 | 42,6 | 1,13 | 9,07 | 0,08 | | 16,4 | 14,7 | 1,32 | 36,59 | 0,04 | |
| 3 | Strane | 3,1 | 44,4 | 1,11 | 10,4 | | | 6,4 | 12,8 | 1,27 | 37,65 | | |
| 4 | Kapshtice | 12,6 | 42,5 | 1,25 | 9,77 | | | 12,1 | 18,7 | 1,21 | 29,75 | | |
| **Bitincka Basin** | | **52** | **41,8** | **1,12** | **9,61** | **0,07** | **3,76** | **50,2** | **16,3** | **1,28** | **34,1** | | **17,8** |

*Source: AKBN and others*

***Has-Kukës-Lurë Region***

**e) Trull Surroj Mine**

The Trull-Surroj deposit is situated in south west about 30km from the town of Kukesi. Total proved reserves are about 29.4 million tons. The reserves of Fe-Ni are about 5.1 million tons (Ni 0.98%, Fe 34%, SiO2 32%, Co 0.048%), while the reserves of Ni-Si are about 24.3 million tons (Ni 1.03%, Fe 22%, SiO2 40%, Co 0.044%).

**f) Mamez Mine**

The Mamez Mine is located in the south-west about 17km from the town of Kukesi. Total proved reserves are as follows:

Ni-Si of primary crust: 15 205 000 tons, Ni= 1,033%, Fe=16.5%, Co=0.033%

Fe-Ni: 19 052 700 tons, Ni= 1.0%, Fe= 35.81%, Co=0.056%

Ni-Si of secondary crust: 9 545 700 tons, Ni=0.918%, Fe= 21.90%, Co=0.06%

**g) Nome Mine**

The Nome Mine is located in the south-west about 50km from the town of Kukesi. Total proved reserves are as follows:

Ni-Si of primary crust: 2 364 616 tons, Ni=1.39%

Fe-Ni: 6 023 436 tons, Ni=0.96%

Ni-Si of secondary crust: 1 247 687 tons, Ni=0.96%

Prognose gives over 30 million tons with Ni=1.2%

***Librazhd-Pogradec Region***

**h) Guri Kuq Mine**

The Guri Kuq Mine is located close to the national road Prrenjas-Pogradec, about 3km from the town of Progadeci. Reserves of Fe-Ni are about 53.3 million tons (Ni 0.97%, Fe 42%, SiO2 17%, Co 0.075%).

**i) Prrenjas Mine**

The Prrenjas Mine is located close to the national road Librazhd-Prrenjas, about 0.5km from the town of Prrenjas. The reserves of Fe-Ni are about 30.3 million tons (Ni 1.04%, Fe 47%, SiO2 10%, Co 0.06%).

**j) Xixillas Mine**

The Xixillas Mine is located close to the national road Elbasan-Korce, about 6km from the town of Elbasan. The reserves of Fe-Ni are about 1.3 million tons (Ni 1.02%, Fe 49%, SiO2 5.4%, Co 0.068%). The mine is currently closed.

**k) Skroske Mine**

The Skroske Mine is located close to the national road Elbasan-Korce, about 14km from the town of Elbasan. The reserves of Fe-Ni are about 21.8 million tons (Ni 0.99%, Fe 50%, SiO2 4.0%, Co 0.065%). The mine is currently closed.

**l) Bushtrice Mine**

The Bushtrica Mine is located close to the national road Elbasan-Korce, about 3km from the town of Elbasan. The deposit is separated in two zones, central and west. The reserves of Fe-Ni are about 2.0 million tons (Ni 1.06%, Fe 49%, SiO2 5.0%, Co 0.06%).

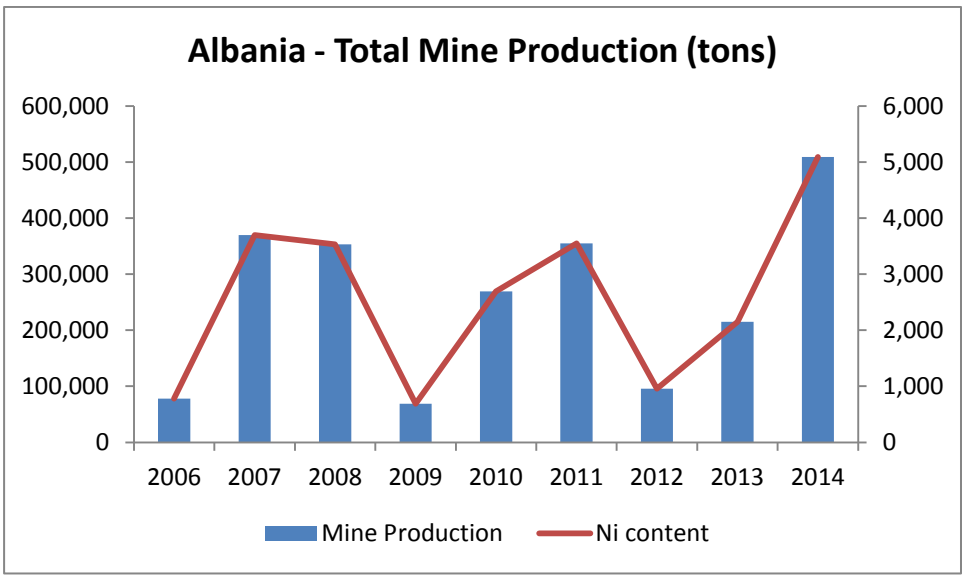
**Mine Production**

During the 1980s production of nickeliferous iron ore in Albania ranged from 1 to 1.2 million tons per year, of which about a half was used at the Metallurgic Combine-Elbasan. This plant was closed due to the non-adaptability of the smelting technology to the characteristics of the ore and relatively low level technology. Albanian nickel was also used to be exported in Czechoslovakia supplying an amount of 0.4 million tons of iron-nickel to the Serret Smelting Plant a nickel producing plant which was closed in 1992.

In the past various attempts have been made to restart nickel production in Albania especially in cooperation with foreign companies. A serious effort was made in 1995 when the Norwegian company Elkem carried out semi-industrial smelting test for 40 tons of nickel silicate ore from the Bitincka mine to produce ferro-nickel. In 1998, it was given the first mining licence to the Albanian private company “Adi” shpk to exploit the nickel deposit of Bitincka. This company started the production of nickel ore exporting in Republic of FYRO Macedonia. In 2003 the same company obtained other mining licences for the nickel deposits in Kukes. Another Albanian company has instead obtained a mining licence in the district of Librazhd.

Nowadays several Albanian companies have the permits to exploit the iron-nickel and nickel-silicate deposits, producing nickel ores and exporting it to FY Republic of Macedonia and Serbia-Kosovo. In

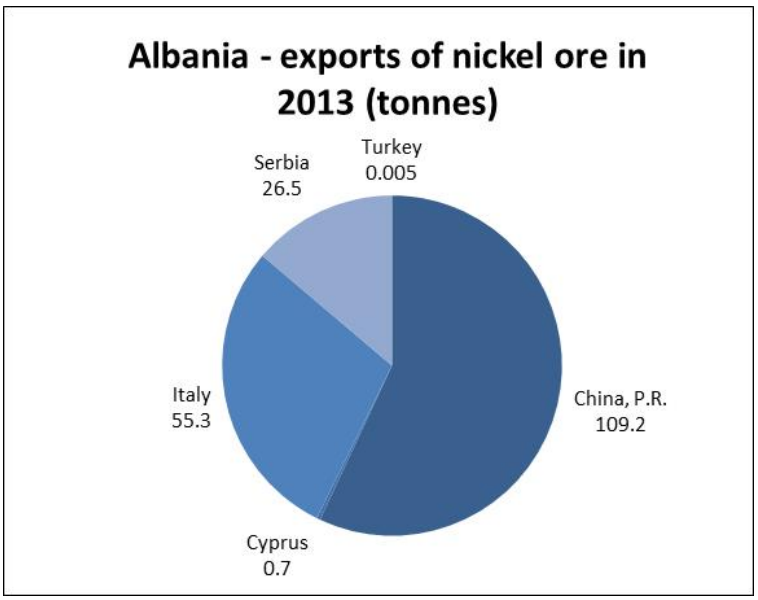
the period 2006-2014, total nickel mine production has had ups and downs with the peak reached in 2014 at 509,136 tons.




*Source: INSG and others*

**Nickel Trade**

In 2013, according to UN Comtrade, Albania exported 192,000 tons of nickel (gross weight) in the form of ores and concentrates. The main destination was China P.R. with 57% of all the material exported, followed by Italy, with almost 29%, and Serbia (Kosovo), with just below 14%. In 2014, the latest data available shows that all the ore – 239,000 tons – was exported to Serbia (Kosovo).




*Source: UN Comtrade*

## GREECE

### Nickel Reserves and Resources

Greece is one of the EU Member States that has significant mineral resources in terms of quality, quantity and variety of ores and minerals with a great industrial interest and a wide range of applications. Nickel represents a relevant part of the Greek industry.

The nickel ore deposits are associated with Pelagonian – Sub-pelagonian – Almopia geotectonic belts, which are characterized by the presence of ultramafic rocks. The evolution of these belts and the significant presence of ultramafic masses in Greece suggest positive possibilities for the presence of new important nickel ore deposits.

Total nickel resources in Greece are estimated at about 240 Mt and are mainly spread over three large areas of Greece: Central Euboea, Neo Kokkino area and the county of Viotia and Northern Greece in the area of Kastoria.




*Source: LARCO*

G.M.M.S.A. LARCO currently operates three nickel mines (Agio Ioannis, Evia and Kastoria Mine) and owns a large number of mining survey permits which could lead to the strengthening of the mining activities if the final results will be positive.

| Mines | Resources (tons) | Ni content avg. (%) |
|---|---|---|
| Agios Ioannis | 51,000,000 | *1.00* |
| Evia | 155,000,000 | *0.99* |
| Kastoria Mine | 9,000,000 | *1.02* |
| Parnitha | 15,000,000 | *0.80* |
| Skyros | 2,000,000 | *1.10* |
| Paleohori | 800,000 | *1.40* |
| Edessa | 1,500,000 | *1.00* |
| Vermio | 2,000,000 | *1.10* |
| Lesvos | 500,000 | *1.30* |

*Source: LARCO*

**Main nickel deposits in Greece**

***Evia Mines***

There are five operational surface mines at Evia. The mines have modern surface earthmoving equipment owned by LARCO. Transportation of ore from the grinding unit to the enrichment and homogenization installations is done by an integral 7.5km conveyor belt system, which also takes advantage of the altitude difference to produce electrical energy. Annual production is 1,200,000 to 1,500,000 tons of ore. Evia ores is high in iron and silica and has around 6% moisture

***Agios Ioannis Mines***

The Agios Ioannis mines at Neo Kokkino, 7km from the Larymna's smelter. The mines consist of one underground mine and three surface mines. A fourth surface mine is being opened up as an extension of a former surface mine. There are two grinding and screening units, as well as one ore beneficiation and homogenization unit. The transportation of the ore to the metallurgical plant is made by trucks. The mines' annual production is 500,000 to 600,000 tons of ore (magnetic separation). The ores is high in iron and lower in silica with about 5% moisture.

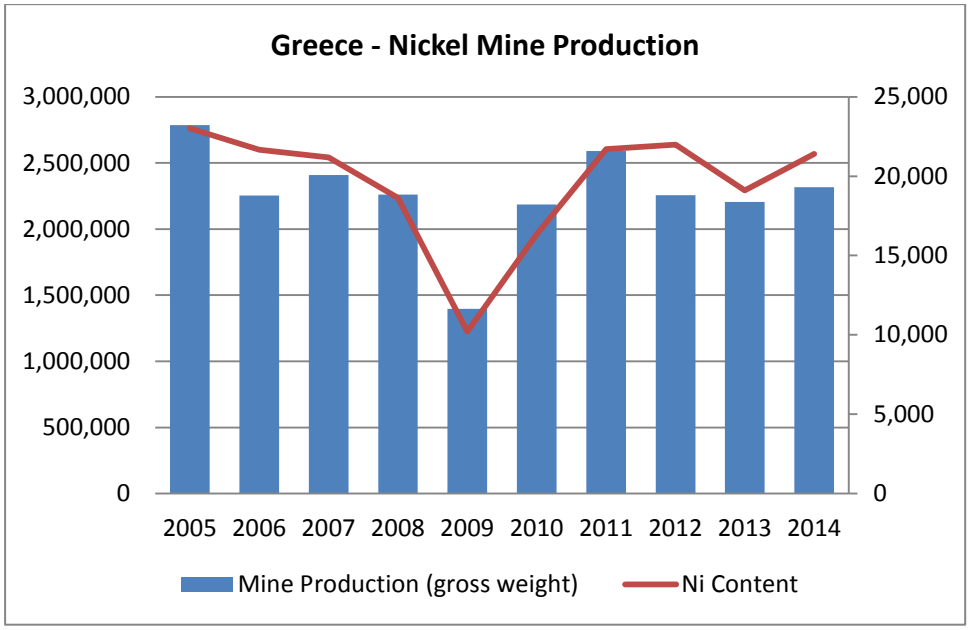
***Kastoria Mines***

There are three main deposits at Kastoria, near the Albanian border, two of which are currently being mined. Surface mining is employed operating with contracting excavation and ore-stripping teams. There are also grinding, screening and beneficiation units. The annual production is 350,000 to 450,000 tons. The ores contain significant magnesium, is relatively low in iron and has high silica. Compared to Evia and Agios Ioannis the Kastoria ores are wetter with around 10% moisture.

**Mine Production**

In the period 2005-2014 mine production slightly decreased both in gross weight and nickel content. The decrease was deeper from 2005 to 2009 when the production reached 10,000 tons in nickel

content, since then we have seen an increase, with the only exception of 2013, bringing back the production level at about 21,500 tons.




*Source: INSG, LARCO*

**Primary Nickel Production**

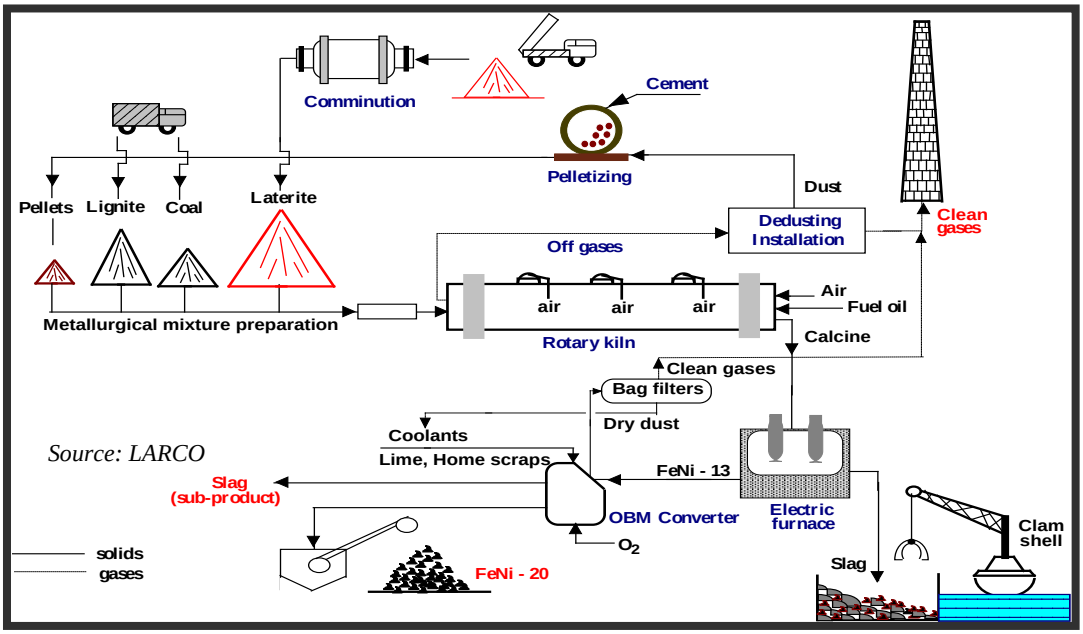
The Greek nickel-bearing ores are treated pyrometallurgically in the plant of LARCO at Larymna about 130km N/NE of Athens. The plant processes the nickel ores to produce ferronickel with an18%-24% nickel content. The processing of the ore takes place in 4 phases:

- *Handling of raw materials and preparation of the metallurgical mixture*
- *Pre-heating and pre-reduction in the rotary kilns*: LARCO operates four rotary kilns of which two are 90m long and 4.2m diameter, one is 90m long and 5.2m diameter while the fourth is 126m long and 6.1m diameter, one of the largest in Europe. The rotary kilns can process material at 485tph which is equivalent to 3.8Mtpa. Temperatures are 400°C at the entrance and 850°C at the exit.
- *Electric Furnace reductive smelting*: the product of the rotary kilns is fed into five Submerged Arc Electric Furnaces. Each of the furnaces is 6m high; four being 13m in diameter, while the fifth has an 18m diameter. The temperature developed with the aid of the electric power is 1600°C and allows the reductive smelting of the fed material and the formation of two separate phases. One metallic containing all of the nickel and part of the iron and one slag phase containing oxides of the gang material of the calcine that is the remaining part of iron silica, calcium, alumina and magnesium mainly. The metallic and slag phases are removed systematically from the furnace. The metallic phase for further treatment, nickel enrichment and refining and the slag for side exploitation and dumping. The electric furnace slag produced comprising about 85% of the feed is granulated with a strong stream of seawater.
- *Enrichment – refining in OBM type converters:* The Electric Furnace product is fed to OBM type Converters. With oxygen and propane blowing through the bottom, a quantity of iron is oxidized resulting to the enrichment of the ferronickel to the final desirable nickel concentration, which is typically 20%.There are two Converters of capacity 50 tons each. At the same time the product is refined, with the addition of proper fluxes. In this way sulphur and phosphor concentrations are limited to the marketable values.

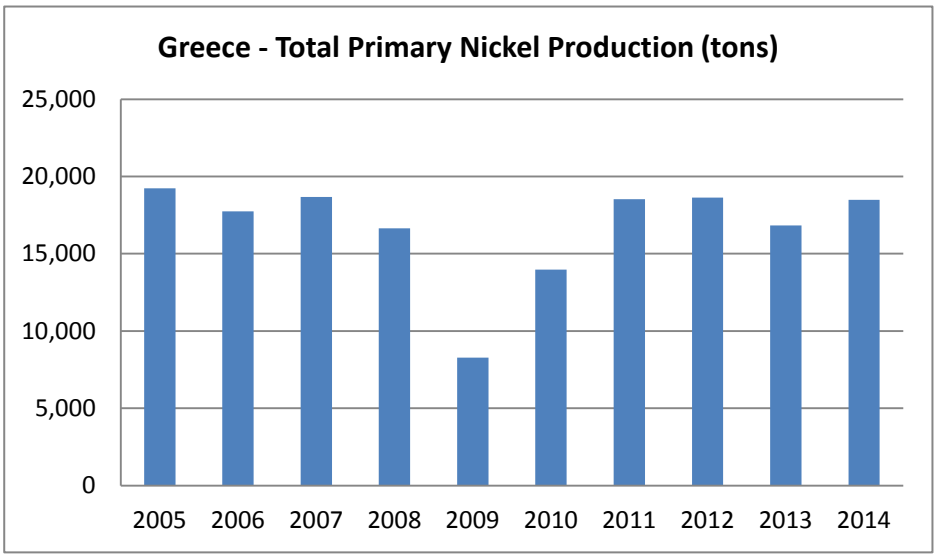
  During the process the temperatures are 1600-1700° C. When completed, the final smelted product is granulated. The size of the granules varies between +3 -40 mm and is the final product.

The slag produced during the refining is a by-product, which after milling to a size of -5 mm, is sold as heavy inert material for the production of special type of concrete and for covering of oil tubes or other similar works, in Europe, North Africa and Middle East.

## The Larymna Plant - Flowchart




In the period 2005-2014 LARCO's ferronickel production average about 18,000 tons with the highest production level reached in 2005 at 19,235 tons. The production bottom out in 2009 at 8,269 tons.

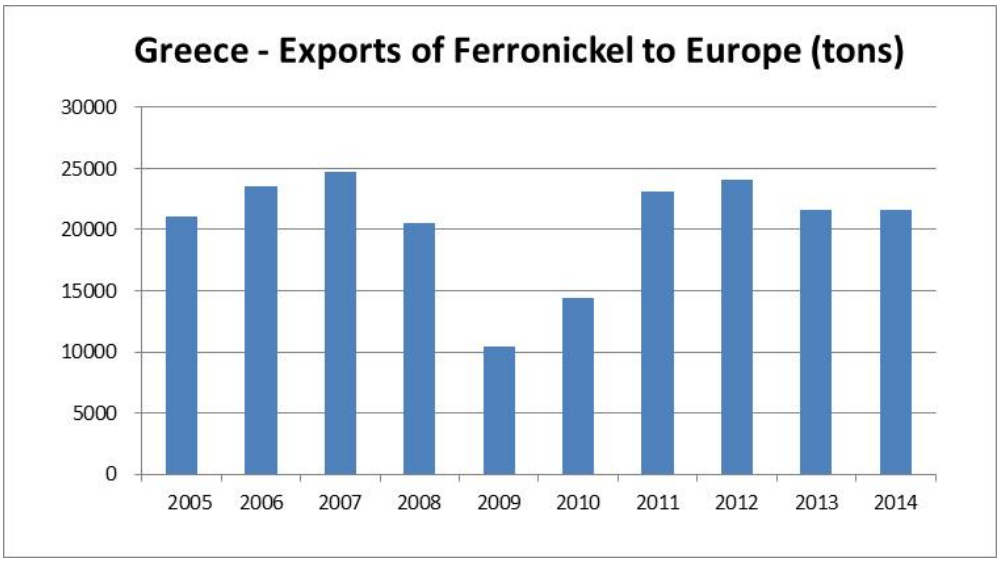



*Source: INSG, LARCO*

**Nickel Trade**

Though Greece mostly uses its own ore feed to produce ferronickel, the trade statistics also show imports of nickel ore. Indonesia, Philippines, Turkey and Guatemala have been in recent year exporters of nickel ore in to the country but it is worth to point out that in some cases this material is re-exported to neighbour countries.

The majority of ferronickel produced in Greece is exported to other European countries to supply the main stainless steel facilities, so total exports to Europe follows closely production.

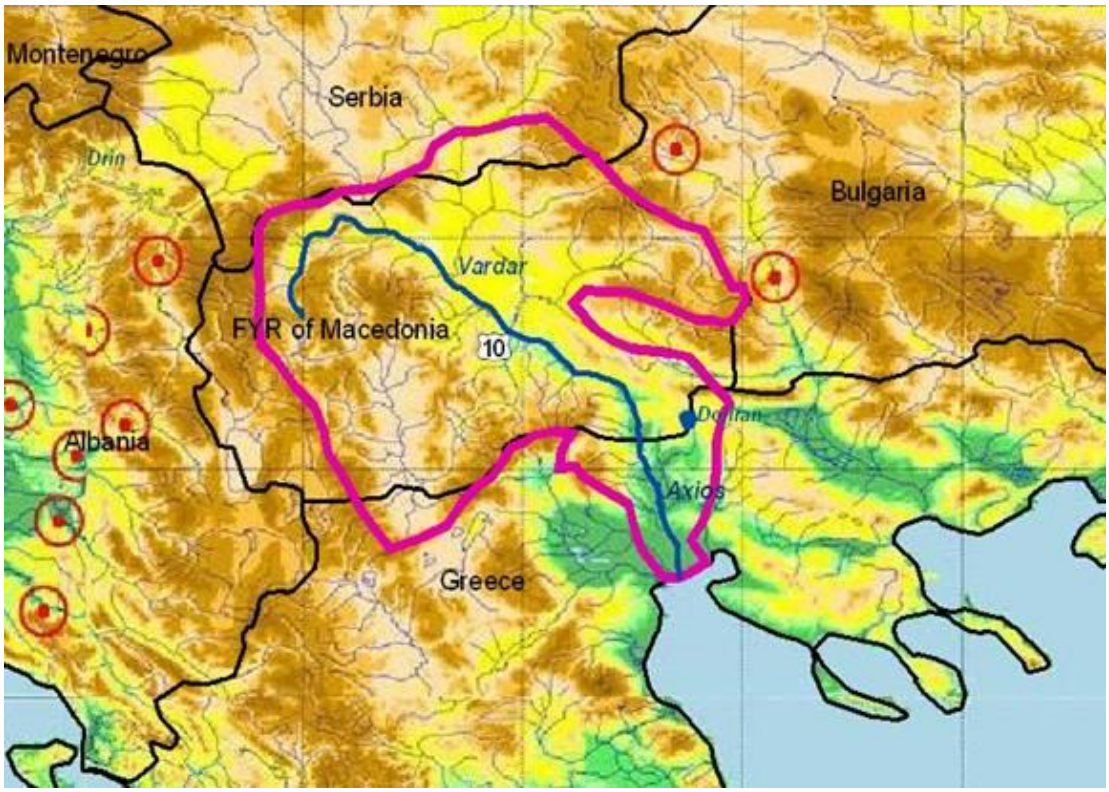



*Source: LARCO*

## FY REPUBLIC OF MACEDONIA

### Nickel Reserves and Resources

The FYRO Macedonian ophiolitic complex is an integral element of the Eastern Mediteranean, in this region most of the Jurassic ophiolites belong to the Oman subduction related type. The Vardar zone, which represents a complex tectonic block located between the Serbian-FYRO Macedonian massif in the east and Dinarides and Helenides in the west, played the most important role in the formation and spatial displacement of Jurassic ophiolitic complexes and associated ferronickel deposits in the southern Balkan Peninsula. The Vardar zone represents a belt over 1000km long and 60-80km wide that extends in the NW-SE direction from Belgrade through Serbia and FYRO Macedonia to the Aegean Sea in the Northern part of Greece, where it subsides and turns eastward as an element of the Izmir-Ankara zone.




*Source: Inweb*

Total nickel resources in FY Republic of Macedonia are currently estimated at about 90-100 Mt of which 30 Mt remaining at the Rzanovo deposits (5-6 Mt with open pit and 25 Mt underground), 2 Mt Studena voda 2km south from Rzanovo mine, 50 Mt on Crna Tumba 20 km south-west from Rzanovo mine, 10 Mt on Rakle close to town Prilep. About 20 Mt are located in the Takovo area in central Serbia.

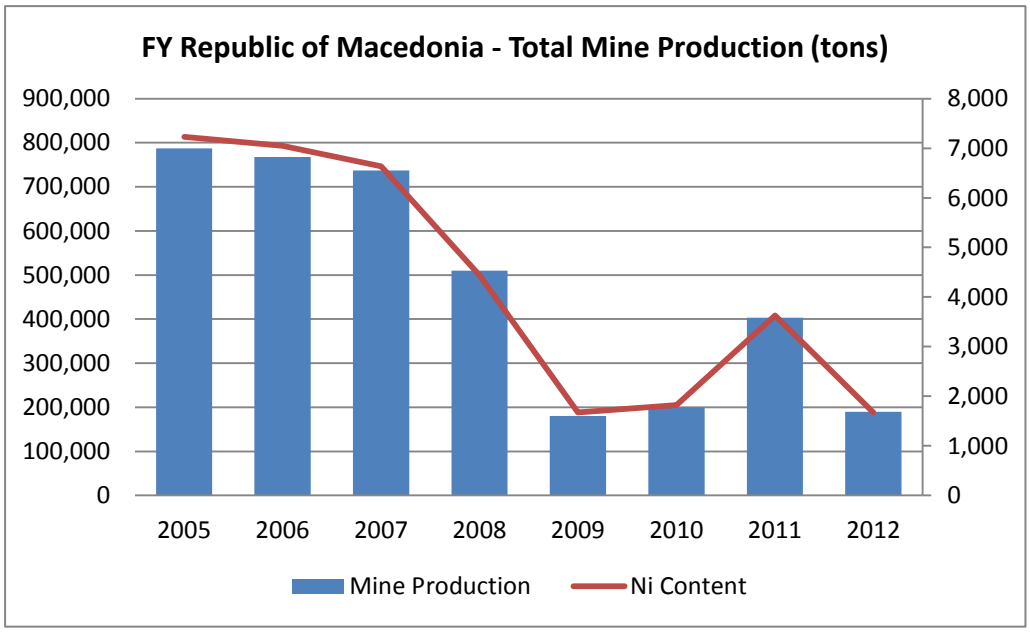
### ***Rzanovo Mine***

The Rzanovo deposit is located in the Kozuf ore district near the state boundary of FY Republic of Macedonia and Greece. This is one of the largest ferronickel deposits in the Vardar zone. The formation of ferronickel ores in the Rzanovo deposit is directly related to erosion of lateritic weathering crusts developed after Jurassic ultramafic rocks.

The Rzanovo mine started operation in 1980 and since then has produced 12 Mt of ore. Average nickel content in the ore is 0.9-1.0% with 28-35% Fe. Since February 2005 the Rzanovo mine was part of the Cunico Resources and the ore used to be carried from the mine to the Feni Industries plant by a 36.5km conveyor belt, the longest in Europe. The Rzanovo mine has been closed by Cunico in January 2013.

**Mine Production**

Over the years total mine production in FY Republic of Macedonia ranged between 5,000 and 7,000 tons in nickel content with the peak reached in 2005.



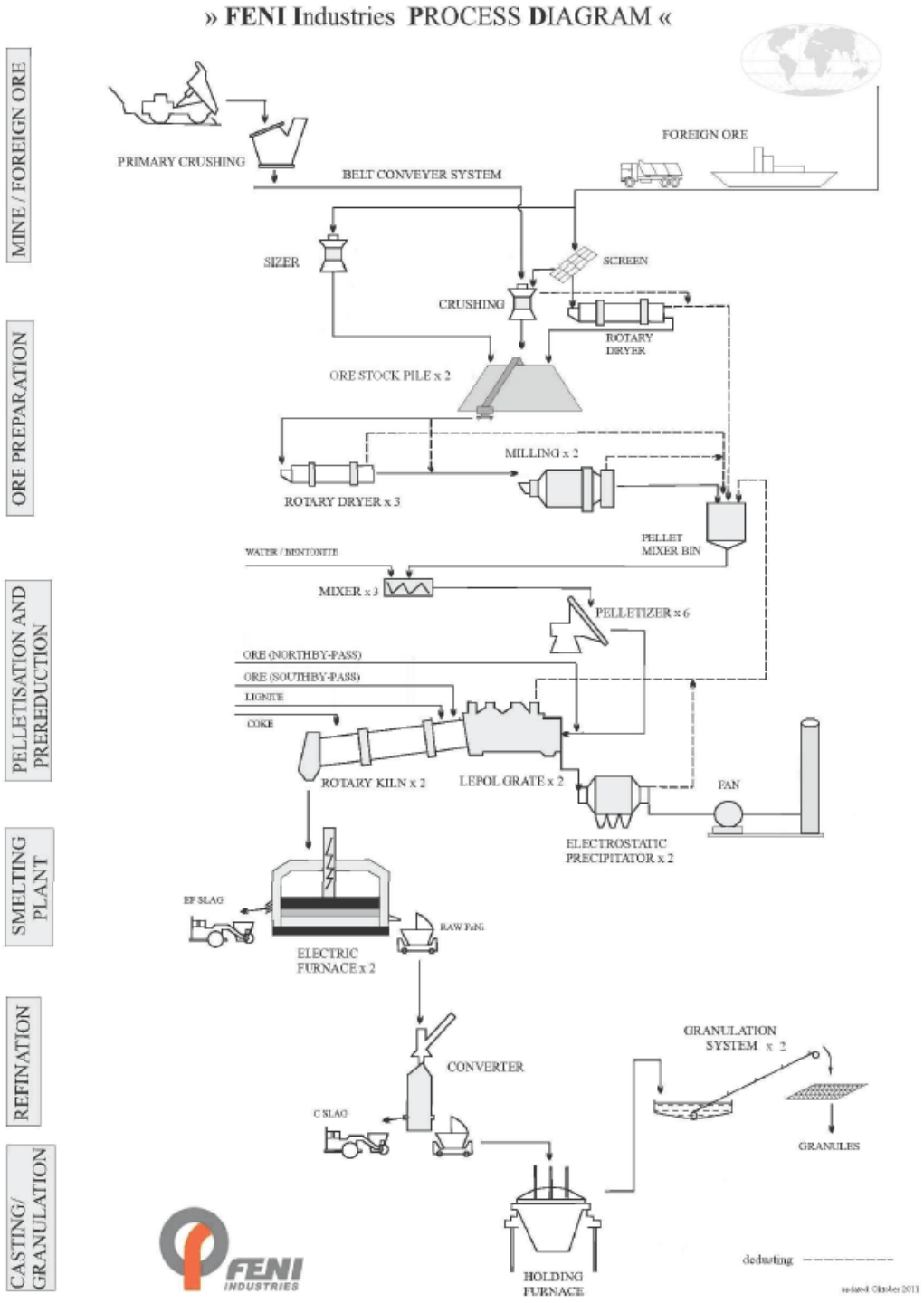

*Source: INSG estimates*

**Primary Nickel Production**

Ferronickel production in FY Republic of Macedonia occurs at the FENI Industries pyrometallurgical plant, located in Kavadarci about 100km south of Skopje and 140km north of the Port of Thessaloniki in Greece, the main import/export site of the plant. The plant is in operation since 1982 and it was acquired by Cunico in 2005.

The plant is a two-line rotary kiln electric furnace facility with the biggest rectangular electric furnaces of their kind in the world. On each line, the plant operates a rotary dryer that feeds into a rotary kiln where the nickel ore is dried and reduced and then fed into an electric furnace for complete reduction into a molten nickel/iron alloy. The nickel/iron alloy is then placed into an oxygen converter and blown with oxygen to reduce the iron content, thereby increasing the nickel content. The ferronickel is then transported to a holding furnace where the temperature is raised to cast the metal, in form of granules.

Ferronickel production is very energy intensive and when the two lines are working at full capacity energy needs are at capacity levels of 100-120 Mwh, which due to the limitations of the local power generation capacities the plant is forced to import cross border.

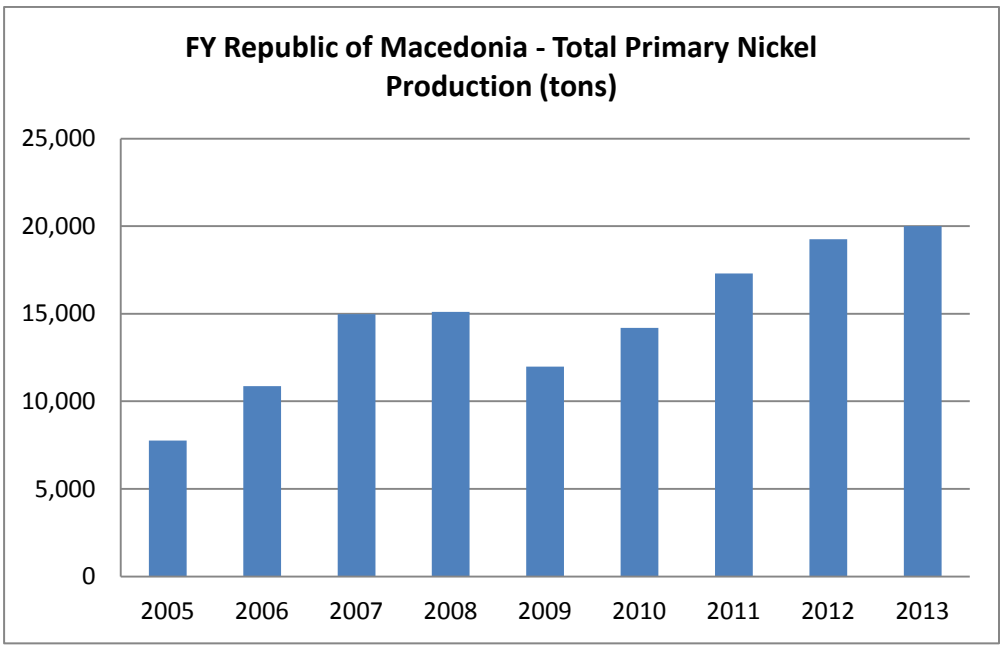



*Source: Cunico FENI Industries*

In the period 2005-2013 primary nickel production in FY Republic of Macedonia increased by an compound annual growth rate of 11%. After the acquisition of the FENI Industries by Cunico the new management has implemented changes in production technology.

In 2006 the final product was changed from ingots to granules and the second furnace was commissioned. By the year 2008 the production capacity was tripled to 15,000 tons. In 2009, due to the global economic crisis one of the furnaces was idled and the production reduced. In 2010, after the

refurbishment of the second furnace the production increased again reaching 14,413 tons. In 2013, the level of production peaked at 20,000 tons.



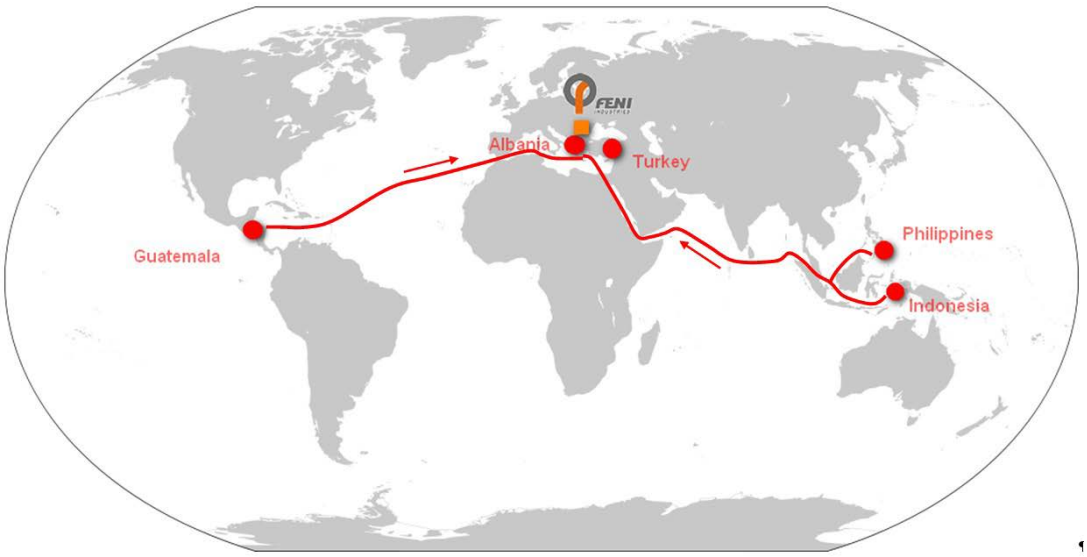

*Source: INSG estimates*

**Nickel Trade**

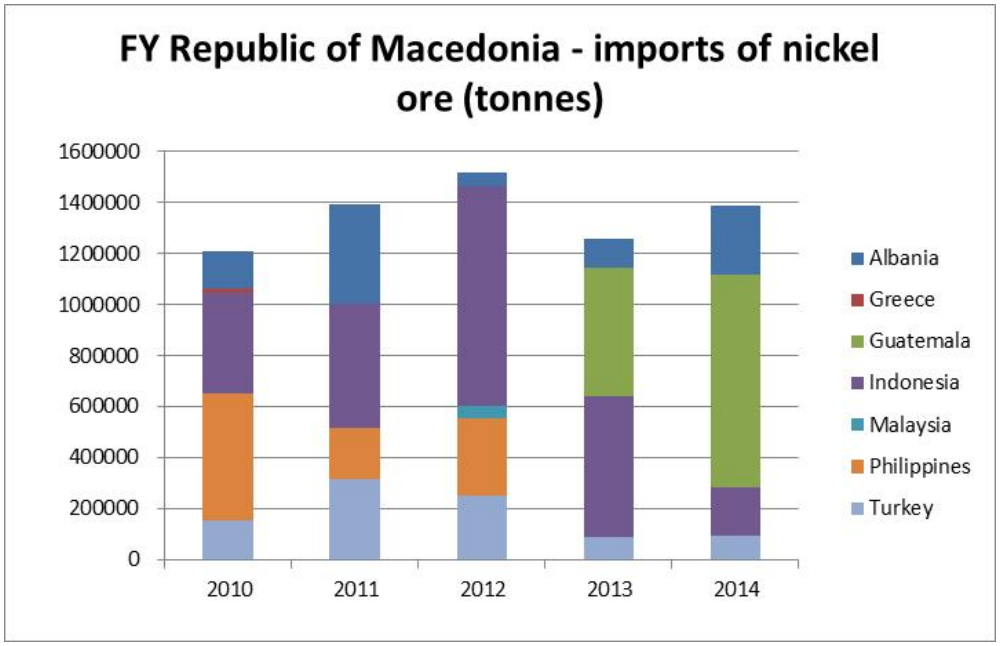
Generally speaking, FY Republic of Macedonia imports nickel ore and exports ferronickel. The Philippines and Indonesia were the main suppliers of nickel ore to FY Republic of Macedonia from 2010 to 2012 with a combine figure of 77% in 2012.

However, the Philippines stopped exporting to this country in 2013 and Indonesia's share decreased to 14% in 2014 since it peaked in 2012 with 57% of total imports.

In 2012, Guatemala started exporting nickel ore to FY Republic of Macedonia with the first quantities of ore were mined in September and reached the Thessaloniki Port (Greece) in December. According to trading stats in 2014 Guatemala's nickel ore represented about 60% of the total import.

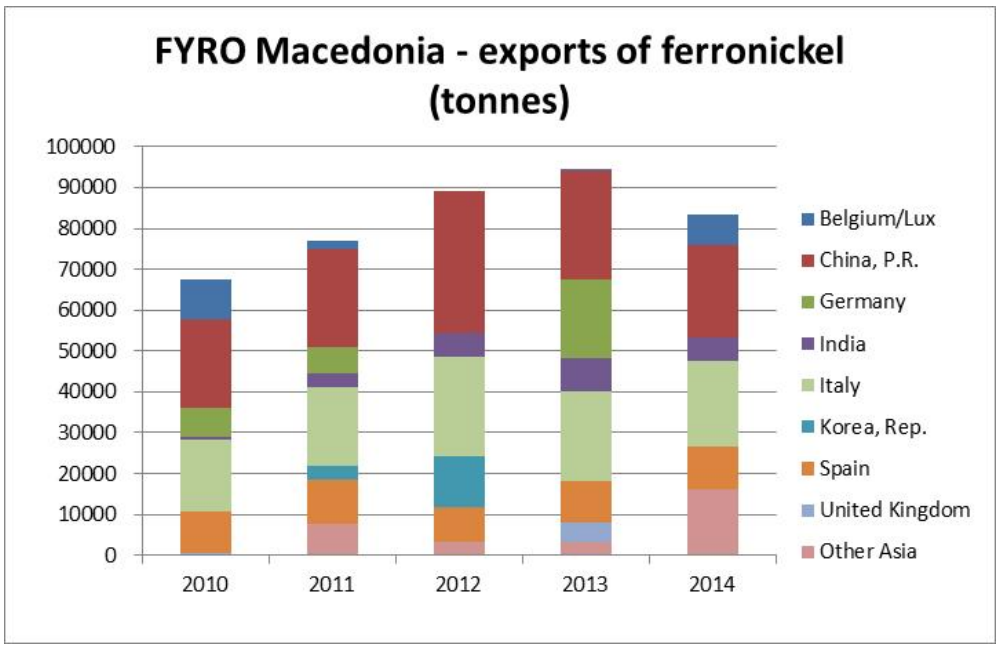



*Source: Cunico CSR Report 2012*




*Source: UN Comtrade*

China, P. R. and Italy have been the two main destinations of the ferronickel produced in FY Republic of Macedonia. For the last 5 years, the two countries together receive more than 50% of the material exported.



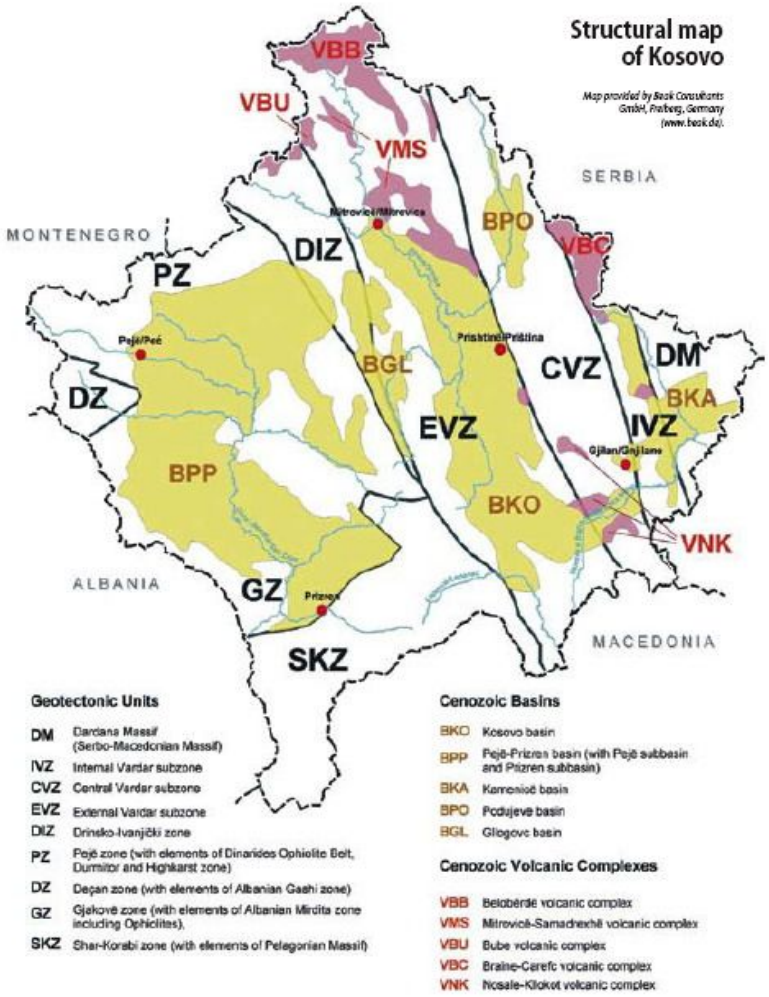

*Source: UN Comtrade*

## SERBIA (KOSOVO)

### Nickel Reserves and Resources

Silicate nickel mine exploration in the territory of Serbia (Kosovo), dates back to 1958 when the first mineralizing nickel appeared in the territory of Gllavica, in the vicinity of Magurë magnesium mine.

Serbia (Kosovo) is geologically divided into two roughly equal-sized halves (the Vardar Zone to the east and the Drina-Ivanjica/Korabi-Pelagonian Zone to the west) by the NNW-SSE trending suture between the Serbo-FYRO Macedonian Geological Belt in Kosovo and the Dinaric Geological Belt of Albania. The Mesozonic transform fault zone, the so called Shkoder-Peje lineament, divides the Drina and the Korabi into two separate, but contiguous zone.




*Source: ICMM Kosovo*

Silicate nickel deposits genetically belong to the decay of serpentines, often they are present in overburden above true laterites, in areas of contacts of ultrabasic rocks with other geological formations.

Two deposits of Ni-Co in Çikatova (Dushkaja and Suka) and Gllavica have been exploited as open-pit mines. The ore mining is carried out only by excavation not using blasting works. Mining reserves are estimated under the former Yugoslavian Reserves/Resources Classification Scheme as follows:

| **Region** | **Quantity 000/t** | **Fe avg %** | **Ni avg %** | **SiO2 avg %** | **Co avg %** |
|---|---|---|---|---|---|
| **Çikatova II** | | | | | |
| *Dushkaja* | 7,000-9,000 | *24.29* | *1.29* | *44.09* | *0.05* |
| *Suka* | 0 | *30.56* | *1.36* | *49.17* | *0.06* |
| **Gllavica** | 8,000-10,000 | *21.53* | *1.55* | *50.89* | *0.05* |
| ***Total*** | ***15,000-19,000*** | | | | |

*Source: ICMM Kosovo and others*

Other regional explorations have been carried out in various locations in Serbia/Kosovo.

**Çikatova:** there are other small deposits of nickel silicate ore not included in the calculated reserves outlined above. Total reserves amounts at 3 Mt @ 0.85-1.4% Ni.

**Llapushnik:** 4km west from Old Çikatova there is a deposit covered with a thinlayer of Pilocene deposits. Grades ranging from 0.54-0.66% Ni and 0.03-0.13% Co.

**Grablak:** resources are estimated at 500,000 t, grade estimation is incomplete.

**Likoshan:** the deposit is composed of decayed serpentinised ultrabasic rock, with resources estimated at 500,000 t@ 0.9-1.2% Ni.

**Baks, Kralica:** discovered in 1972-1973. More detailed work was undertaken in 1980-1982. The Ni is located above compact layers of opal and breccias. Resources are estimated at 564,000 t@ 0.65% Ni, 0.04% Co.

**Banjska, Raiçeva Gora (South Kopaonik):** geochemical analysis detected the presence of Ni from 600 to 10,000 ppm over several square km. In Raiçeva Gora laterite is from 5 to 30km. Samples returned grades of 0.4-0.22% Ni.

**Lluzhan (Huna e Lugut):** the laterite is up 25m thick, grading 0.3-0.97% Ni.

**Tërnavica, Murgulla:** sampling gave maximum results of 4.21% Ni, 0.041% Co, averaging 0.75% Ni, 0.024% Co.

**Junik-Bec-Ponoshec:** in this area Ni-Co mineralisation is connected with the laterisation of ultra-basic rocks and with later erosion, that redistributed the metals into Pliocene deposits as a cement in conglomerates and sands. Samples gave 0.40-0.66% Ni, 0.03-0.11% Co.

**Harilaqë-Sllatinë:** formerly a military zone. Grab samples gave 0.6-0.8% Ni.

Other areas contain Fe-Ni similar with those in Albania and Greece in the forms of lenses and layers such as:

**Tërstenik:** the ore body is presented in a form of three lenses, contains 0.98% Ni and 34.4% Fe.

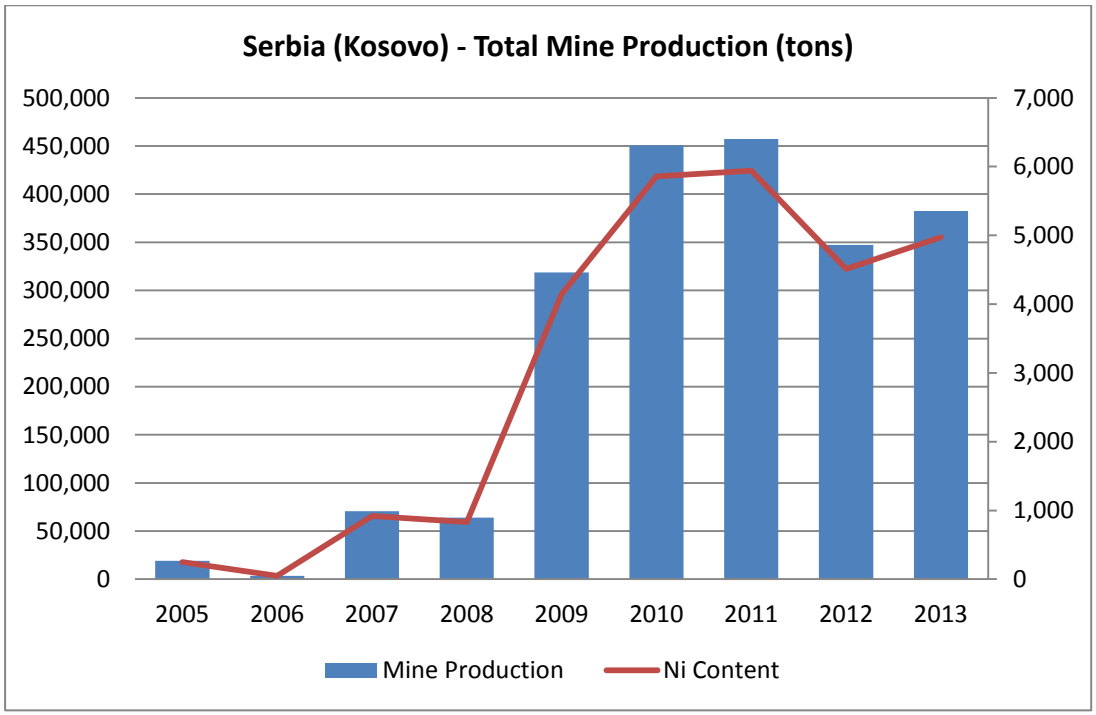
**Vërbovc:** the ore has a detritic and oolitic character with minor pisolites. Oolites are 1-3 mm in diameter and are composed of silicates and iron oxides. Chemical content is around 0.6-1.46% Ni and 25-43% Fe.

**Gradinë:** the ore is present in conglomerates and sands in contact with limestone. Thickness of the ore body is around 0.5-8.5m, with grades of 0.19-0.60% Ni and 6.0-50.0% Fe.

**Ivaja:** mineralisation is spread out over a distance of several kilometres. Samples gave 1.17-1.63% Ni, 34.36-41.57% Fe.

**Mine Production**

According to INSG estimates total mine production reached the level of about 457,000 tons in gross weight and 5,940 tons in nickel content in 2011. In 2013, total mine production was 382,600 tons in gross weight or 4,974 tons in nickel content.



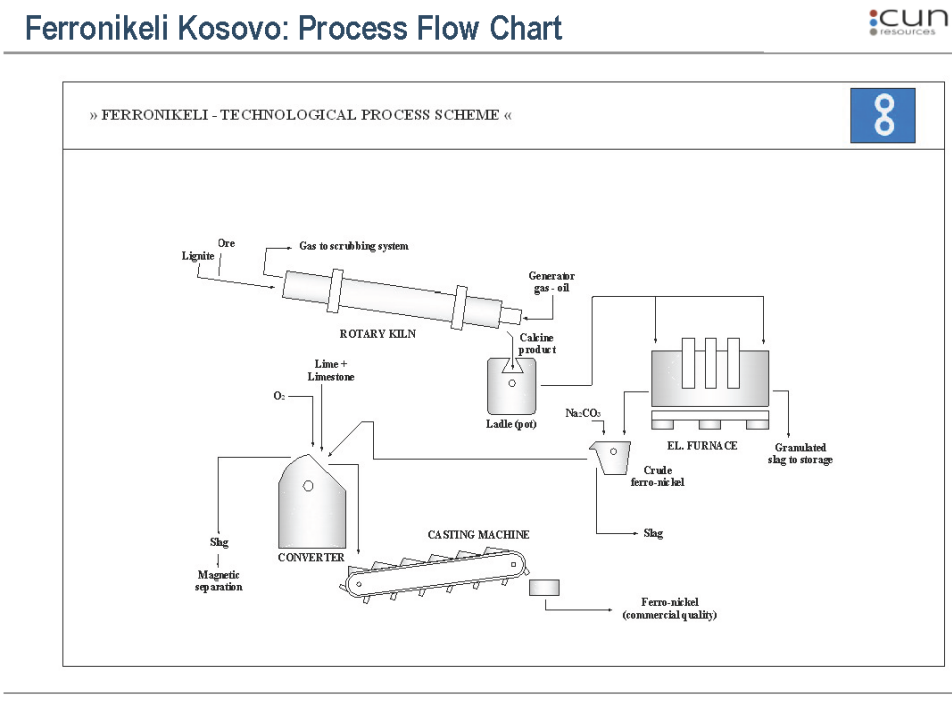

*Source: INSG estimates and others*

The mines and the ferronickel plant have been under-utilized during the 1990's and ceased to operate in 1998. The sites were also damaged during the NATO bombing campaign in 1999. Activity restarted in 2007 after privatization.

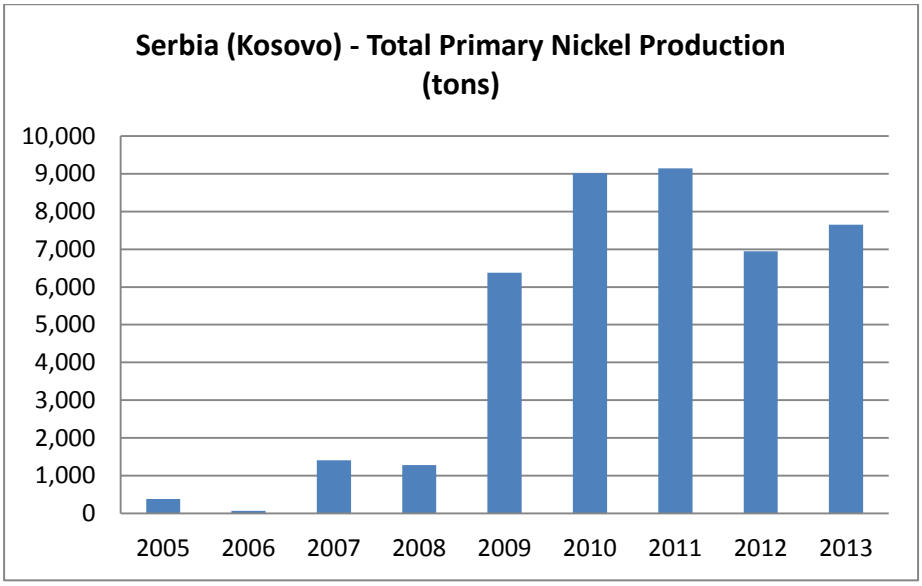
**Primary Nickel Production**

The ferronickel plant (NewCo Ferronikeli), currently owned by Cunico Resources, is located in Gllogovac and was re-commissioned in 2007 after several investments have been made to refurbish the plant.There are two lines, the first opened in 2007 and the second in 2008, and each line consists of a rotary kiln, a smelter and an oxygen converter. The ore is supplied to the plant from Çikatova, Gllavica and Guatemala. The ore from Çikatova is transported to the smelter by dumpers while that of Gllavica by railway. The laterite oxide undergoes specific preparation in hammer crushers where all ore received is reduced in fraction -60mm. This is followed by homogenization and the blending of the ore with lignite to further prepare it for processing. The blended materials are then placed in the rotary kilns, where reduction and calcinations take place.

From the rotary kilns, the ore is moved into the electric reduction furnaces, where approximately 50% of the sulphur in the iron/nickel alloy is removed and a metal with an average 13% nickel content is produced. The remaining sulphur is removed from the liquid metal in the oxygen converters, and the iron/nickel alloy with a nickel content of 17-22% is then cast into ferronickel granules.




Annual production capacity is currently about 10,000-12,000 tons. Total production reached an historical high of 9,143 tons in 2011.




*Source: INSG estimates and others*

**Nickel Trade**

Serbia (Kosovo) imports small quantities of nickel ore from third countries, like FY Republic of Macedonia and Albania and more than 50% for total production from Guatemala and in the past also Indonesia, to complement the domestic mine production. The ferronickel produced with both internal and external feeds is then exported to feed the stainless steel sector, mostly in Italy and occasionally in other countries.

## SLOVENIA

### Historical Developments

Slovenia is the main primary nickel using country in the Balkans thanks at the presence of two stainless steel producing companies: *Acroni* and *Metal Ravne*.

SŽ Acroni is based in Jesenice that has a long history of steelmaking. In this region ironmaking was already developed in the 14th century. In the 19th century, small ironworks came together to establish Kranjska industrijska družba – KID (the Carniolan Industrial Company).

In 1872, Lambert von Pantz, the first director of KID, succeeded in producing ferromanganese in a blast furnace. His invention represented a revolutionary innovation given the level of metallurgical knowledge of the time, and it brought Pantz, as well as the Javornik Ironworks, worldwide fame. After 1960 Jesenice Steelworks developed quickly.

The new company SŽ Acroni was formed in 1992 and since then a number of investments have allowed the company to be one of the main European producer of stainless steel quarto plate. Acroni is also a manufacturer of electrical and structural steels

Also the Meža Valley where the Metal Ravne is located has a long history of steelmaking going back 1620 when Melhior Putz, a young mining speculator and ironworker from the Lavamünd Valley sold his mines and bloomeries in Wölch and St. Gertraud and moved to Črna where he also had the concessions for two smelting furnaces transferred.

In June 1922 the steelworks entered for the first time into the Maribor Commercial Register as a Slovenian Steelworks of the Court Jurij Thurn in Guštanj. In August 1945, at the end of World War II the steelwork was confiscated and changed its name into the “Guštanj Steelworks”. In Spring 1952 the ancient Guštanj changed its name in Ravne na Koroškem and became a town; the factory was named the “Ravne Steelworks”. The current Metal Ravne d.o.o. was officialy founded in 1992.

Metal Ravne’s production includes tool and high-speed steels, structural steels and stainless steels (austenitic, martensitic, ferritic, duplex and precipitation hardened) in the form of billets, bars, square and flat sections.

Both companies are part of the Slovenian Steel Group (SIJ - Slovenka Industrija Jekla) which is a member of the Group IMH-Industrial Metallurgical Holding, a vertically linked internationally cluster of companies.

The main shareholders in the Slovenian Steel Group are the company Dilon d.o.o. (72.2%) based in Ljubliana and the Republic of Slovenia (25.0%)

### Melting facilities

***Acroni***

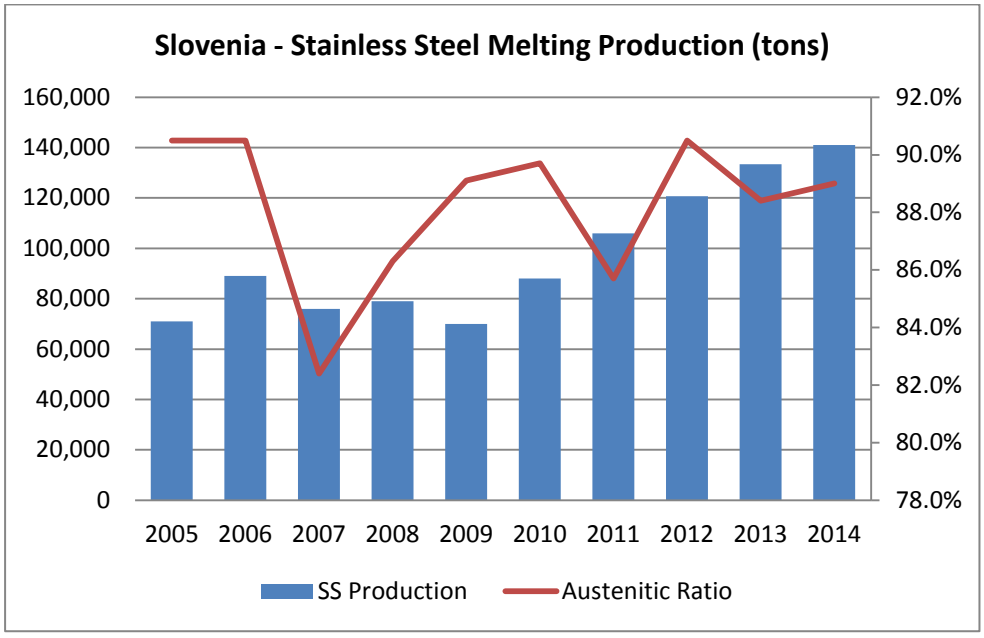
| |
|---|
| **1 X 85t EAF UHP** |
| **2 X 90t VOD/VD** |
| **1 X 90t LF** |

| *Metal Ravne* |
|---|
| **2 X 40t EAF UHP** |
| **1 X 5t EAF UHP** |
| **1 X 45-65t VOD/VD** |
| **1 X 40t VAD** |
| **1 X 2t VIM** |
| **1 X 3t ESR** |
| **1 X 36 t ESR** |
| **1 X 50t ESR** |

*Source: SMR*

### Stainless Steel Production

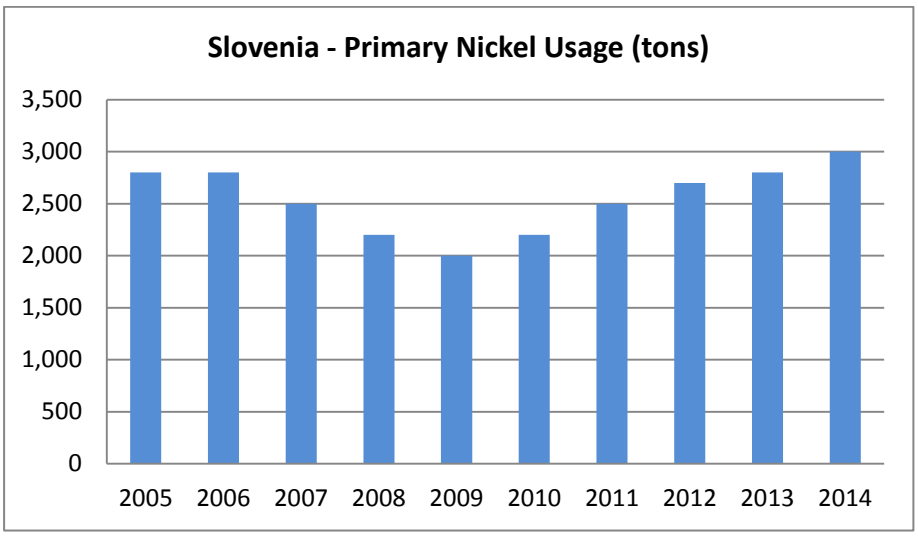
Total stainless steel production in Slovenia increased by an annual compound growth rate of 7.10% from 71,000 in 2005 up to 141,000 tonnes in 2014. The austenitic production currently represents 89% of the total production. In 2014, Acroni's stainless steel production was about 89% of total Slovenian production.




*Source: Eurofer, H.H.Pariser, INSG*

**Primary Nickel Usage**

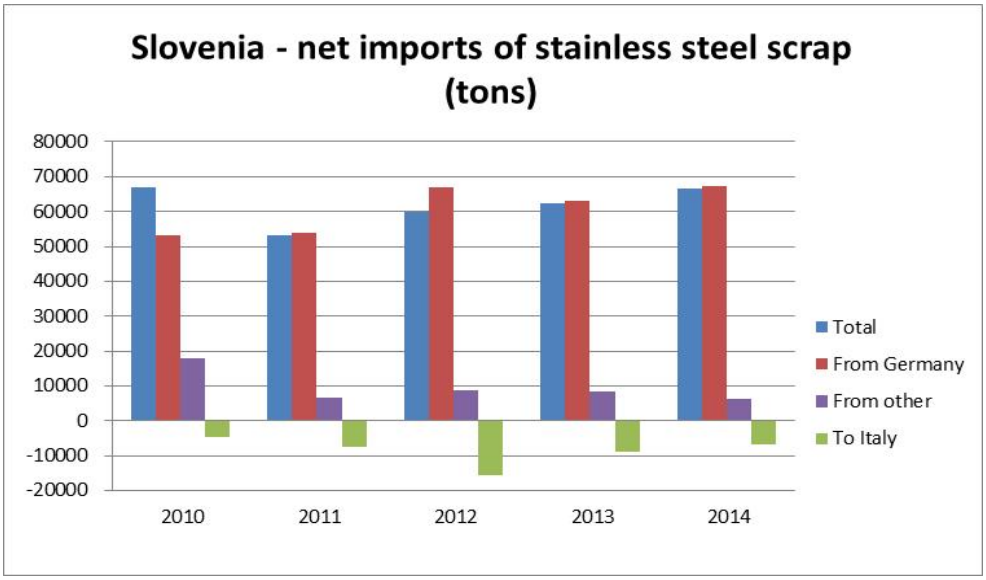
INSG estimates primary nickel usage in Slovenia at about 3,000 tons in 2014 with an increasing trend since it bottomed out in 2009.




*Source: INSG estimates and others*

**Nickel Trade**

In Slovenia, the most important source of nickel units is secondary material, namely stainless steel scrap (SSS). Historical scrap ratios of around 75% in stainless steel production mean that primary nickel only accounts for one quarter of the needs. In that sense, SSS trade is a key factor for the supply of nickel units. Slovenia's main trade partner is Germany – over the last four years, net imports of SSS from Germany were higher than the country's total net imports. Small quantities are also imported from third countries andexported to Italy.




*Source: Eurostat*