Adding value in Serbia: From mining to mineral processing

Rio Tinto strongly believes in a low-carbon future and that we can responsibly contribute to it. The metals and minerals we mine and process, such as copper and aluminum, are essential to tackling climate change and delivering a low-carbon society we all strive for. Lithium and Jadar project are key part of this vision.

For the Jadar project, Rio Tinto has leveraged technical expertise from across our global footprint to develop an integrated mineral processing technology for our Serbian unique mineral, Jadarite. A global team comprising our project staff in Serbia, our Boron operations in California, our processing centre of excellence in Montreal, and our mining and tailings centres of excellence in Australia, have worked tirelessly to develop this innovative mineral processing technology. We plan to produce three valuable industrial products in Serbia - lithium carbonate, boric acid, and sodium sulfate.

Once developed, Jadar will be the largest industrial greenfield project built in Serbia in decades. A new mineral, a new process technology and a new market all require careful considerations in order for Jadar to become a long-life, sustainable operation.

All our efforts continue to focus on delivering the Jadar project in a safe and sustainable manner both for the community and our company.
An innovative processing technology for the Jadar project

It all started with Rio Tinto Serbian and American geologists hitting the undiscovered orebody, which has proven to contain borates and lithium, nearby Loznica in Serbia with the first drill hole in 2004. Since then, we have drilled and tested over 180 km of core equalling two times the air distance from Belgrade to the Jadar site area. In March 2017, Rio Tinto upgraded the Jadar mineral resources to 136 million tonnes in line with international JORC standards.

Our plan is to process the Jadarite ore and produce lithium carbonate, boric acid, and sodium sulfate – our final products – in an industrial facility collocated to the Jadar mine. A new, innovative processing technology is being successfully tested at Rio Tinto’s research centre in Melbourne, Australia, using a pilot plant. We have been supplying feed for this plant with drilled core samples from the Jadar ore body. We wish to relocate this plant to Serbia for further process development and to train our young and talented Serbian processing and chemical engineers.

The small-scale Bundoora integrated continuous pilot plant, BICCPP, was assembled in a joint effort of Australian, American and Serbian professionals from Rio Tinto and our global partners, leading processing experts. Around 2,000 chemical tests were run and about 5,000 pieces of industrial equipment were tested before we were able to declare this processing technology is technically viable. The new processing flow chart is now pending international patent protection (pages 4-5).

All tests have been conducted in accordance with the highest safety standards during all three 24/7 chemical testing campaigns, which also helped us develop important safety operating protocols. The testing campaign has also involved the active participation of a number of Serbian graduates from the Jadar project who will form part of our future in country processing and engineering team. Rio Tinto team is proud of these achievements and of its strong team of talented individuals, who made the Jadarite processing formula work.

An international team of technical experts, chemical and processing engineers has worked on the development of this new technology over several years.
Beyond mining: Creating additional value in Serbia

At Rio Tinto, we have the expertise, technology and resources that allow us to process ore on site, close to our mining locations, and deliver high quality products to our customers around the world.

Co-locating mineral processing facilities on the mine site has proven to bring numerous benefits to communities and countries where we operate, from job creation to direct and indirect economic impact, such as GDP growth, local supplies development, human capital development, and other long-term benefits.

As shown in the accompanying flowsheet, our international team has developed a robust and stable processing technology for our three final products – lithium carbonate, boric acid and sodium sulfate. We have been testing our new, innovative ore processing technology at a pilot plant with an intention to develop a modern underground mine with co-located on-site processing facilities.

Key statistics:
- We drilled over 180km of core
- We ran 2,000 chemical tests
- We installed 5,000 pieces of equipment in the pilot plant
- We collaborated with 40 premium international vendors
- For each 2 tonnes of jadarite concentrate, our processing plant will utilize 1 tonne of chemical reagents
- The piping system in and out of the processing plant will be approximately 225 km long

Our operation at Jadar will go well beyond mining, extending into the downstream chain to deliver added value for both Serbia and Rio Tinto.

Beyond mining:
Creating additional value in Serbia
At a time when the world is witnessing a new industrial revolution and is on a quest to deliver environmentally sustainable growth, a unique mineral jadarite can now be successfully transformed into a valuable product that will support the transition to a low-carbon future.

This transformation is happening mainly through the rise of demand for electric vehicles and energy storage, which use lithium chemicals. In addition to lithium, jadarite contains borates, which will also have an important role in a more energy-efficient future, given their use in wind turbines and insulation fiberglass for buildings. Borates are also building blocks for a number of diverse everyday products, from screens for TV sets and smartphones to detergents and fertilizers.

Sodium sulfate, our third product, is used in the textile industry and production of powdered detergents and glass.

**Jadar products**

**Strengthening the industrial base**
Lithium battery value chain

Many lithium producers offer only limited mineral processing up to the point of a concentrate which is then exported internationally for further processing.

As shown in the chart below, the Jadar project is planning to continue mineral processing right up to the point of producing a battery grade lithium carbonate which exceeds 99.5% purity. This final product needs to be technically prequalified by producers of cathodes who supply lithium battery producers and ultimately electric vehicle manufacturers. Prequalification process usually lasts from 12 to 18 months.

This highly sophisticated lithium value chain involves a thorough qualification stage gate process to ensure ongoing product quality and safety.

The Lithium battery value chain is relatively new and highly sophisticated requiring specific technical expertise. Jadar will produce a battery grade lithium carbonate thereby adding value to the final product in Serbia.

Mine to EV Market
Top Players by Segment in 2018