

# Bauxite : Croatian national "mineral" : [poster]

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**Durn, Goran; Mileusnić, Marta**

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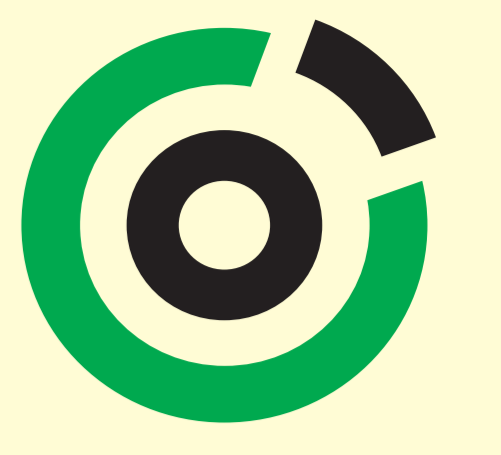


# BAUXITE

## Croatian National 'Mineral'



REEBAUX



### Definition

Bauxite is a product of long-lasting (>1 Ma) subaerial weathering formed under humid tropical to subtropical conditions and characterized by residual concentration of hydrous Al, Fe and Ti. It was named after the village of Les Baux by Pierre Berthe, French geologist who found the ore in nearby deposits in 1821.

Indication of:

- "green-house" period
- tectonically controlled uplift and the associated relative sea-level fall
- globally high temperatures
- concomitant eustatic sea-level high
- positive anomalies of worldwide igneous activity
- paleoenvironmental information (for lack of marine sediments)

Other definitions:

- Ferrallitic soil (pedology)
- Oxisol (palaeopedology)
- Residual rock (geology)

### Mineralogy

Main Al-containing minerals: gibbsite, boehmite and diasporite

Gangue minerals: hematite, goethite, quartz, rutile/anatase, kaolinite

Red colour - presence of Fe-oxides (hematite and goethite)



Gray colour - presence of Fe-sulphides (pyrite and/or marcasite)



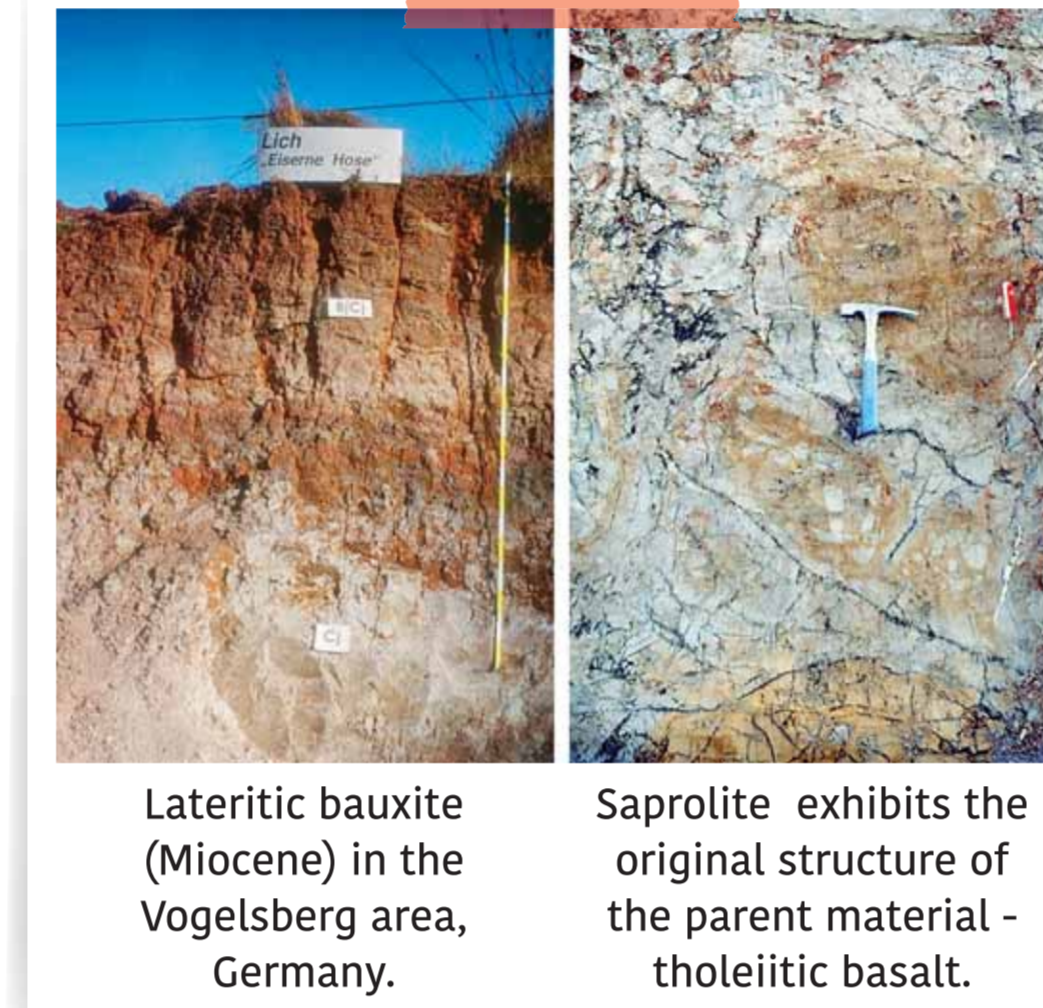
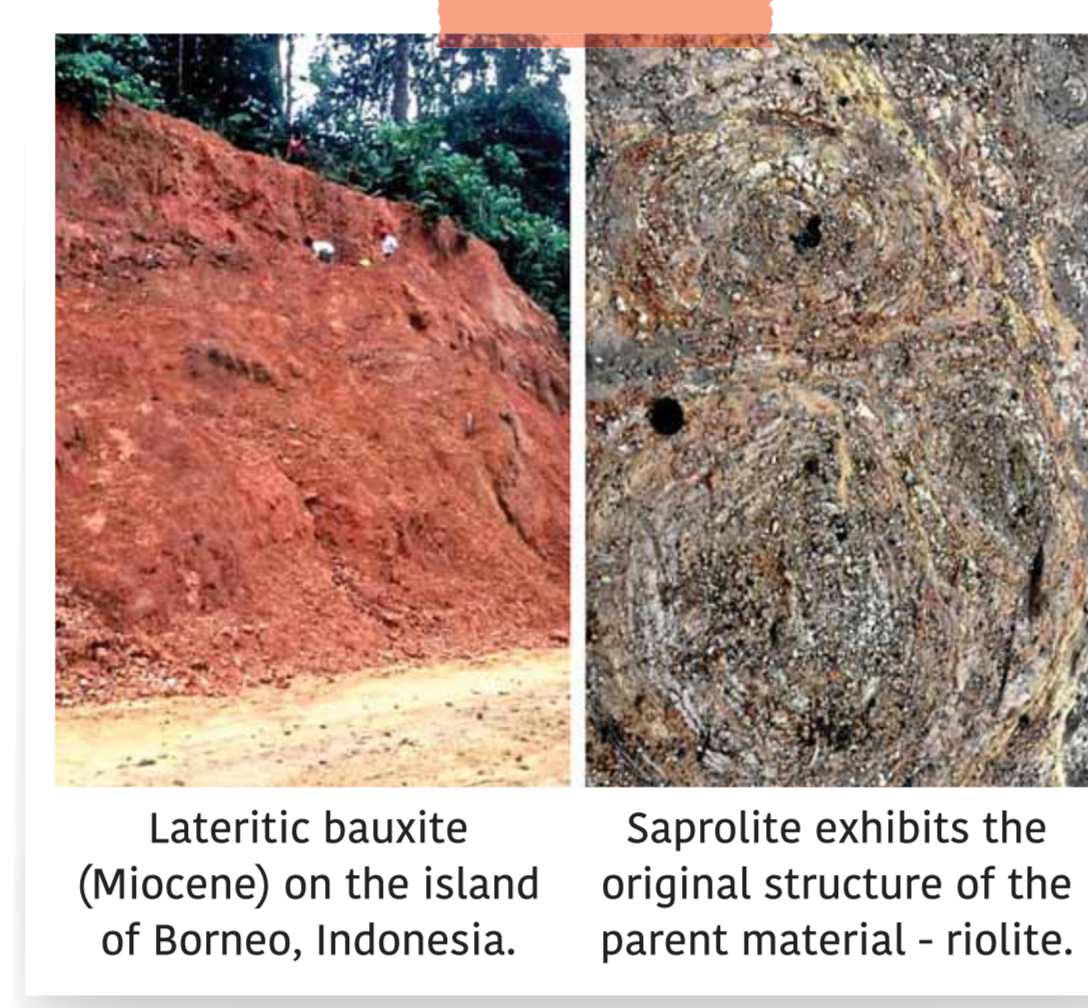
White colour - no iron-bearing mineral phases are present



### Classification

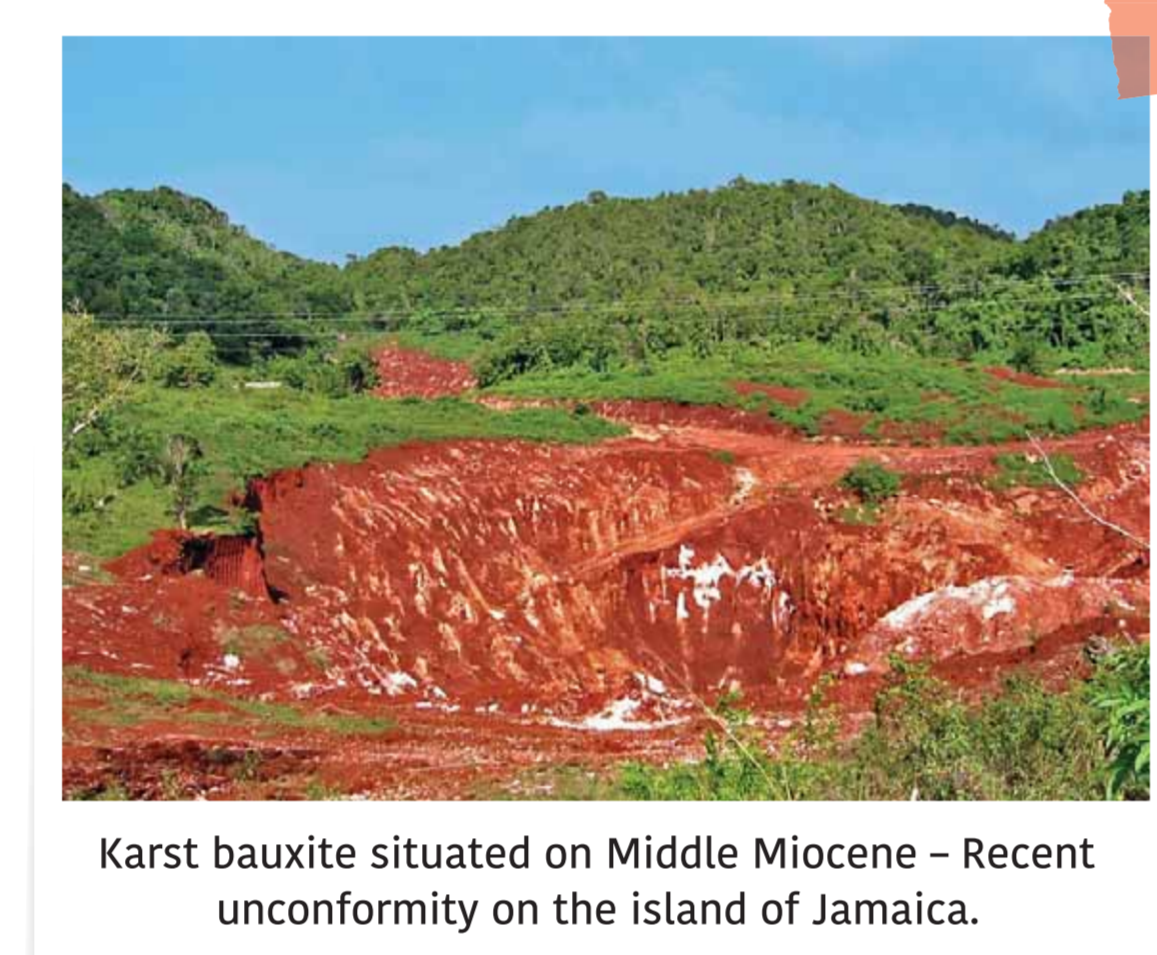
#### Lateritic bauxites

(88% of all bauxites) are associated with weathering crusts on the surface of silicate rocks in a variety of paleogeographic settings. They are developed preferentially on flat-topped plateaus and occur on large continental-scale planation surfaces exposed to humid tropical to subtropical monsoon climate, whereby optimal hydraulic conditions are controlled by the balance between precipitation and evaporation. Lateritic bauxites are spread over large provinces such as Australia, the Caribbean, the Guyana and Brazilian shields in South America, as well as the Guinea Shield and Cameroon in West Africa.



#### Karst bauxites

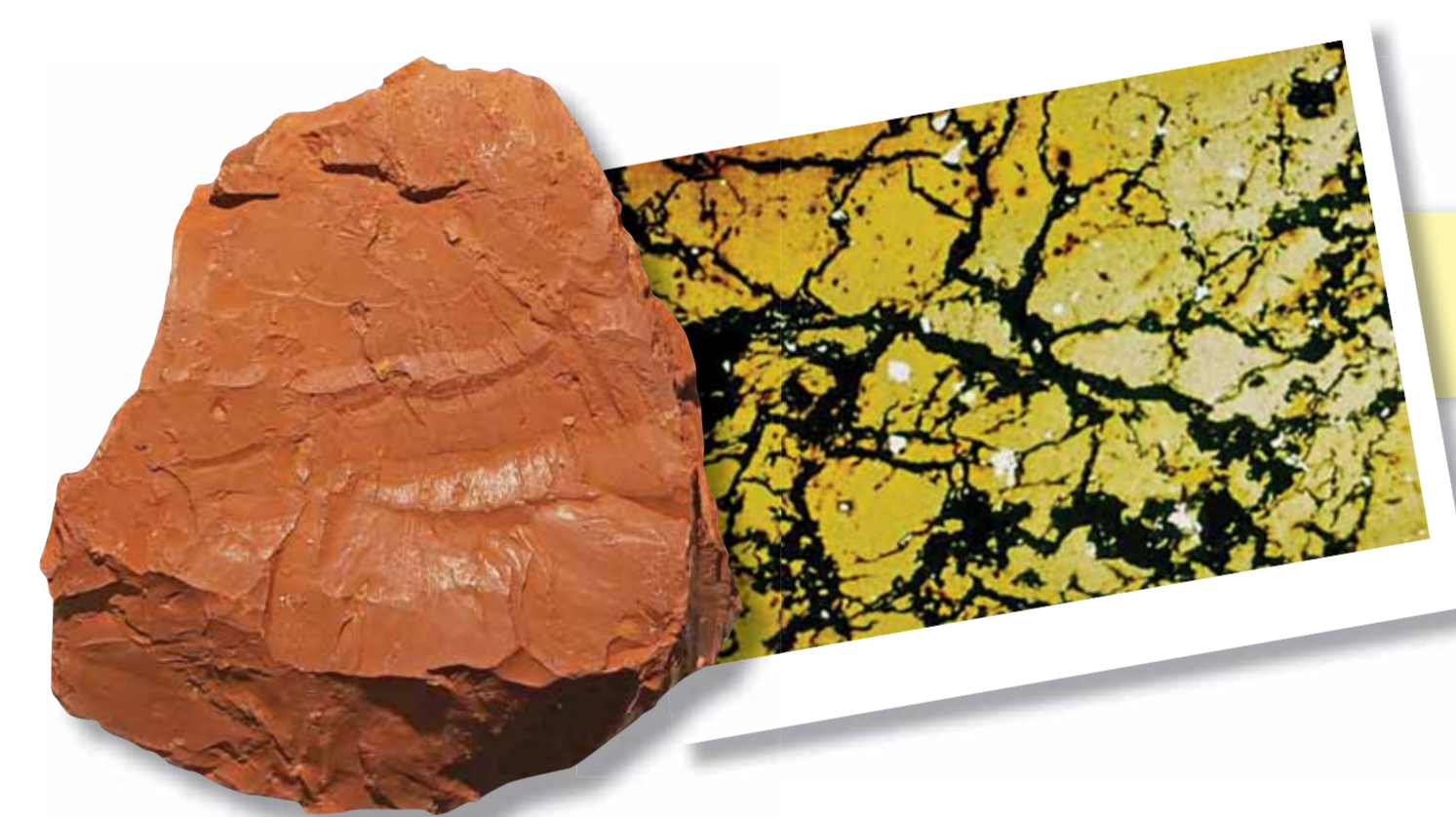
(12% of all bauxites) occur as more or less continuous, mainly redeposited, soil-like blankets covering the karstified surface of (mainly shallow marine) carbonate rocks, which behaved as both a physical and chemical trap. The karstic network provided optimum drainage, necessary for further desilicifications, as well as providing a protected environment from later surface erosion. Karst bauxite deposits preferentially occur in Europe and Jamaica. In Europe the "bauxite belt" is striking from the Hellenides to the Dinarides and to some extent in the Pannonian realm and in the Northern Calcareous Alps. In some isolated karst terrains, bauxites may have formed exclusively from the insoluble residue of carbonate rocks, but it most commonly comprises a variety of external materials, including aeolian dust, volcanic debris and clastic sedimentary particles that were carried to the carbonate terrain by various transport mechanisms.



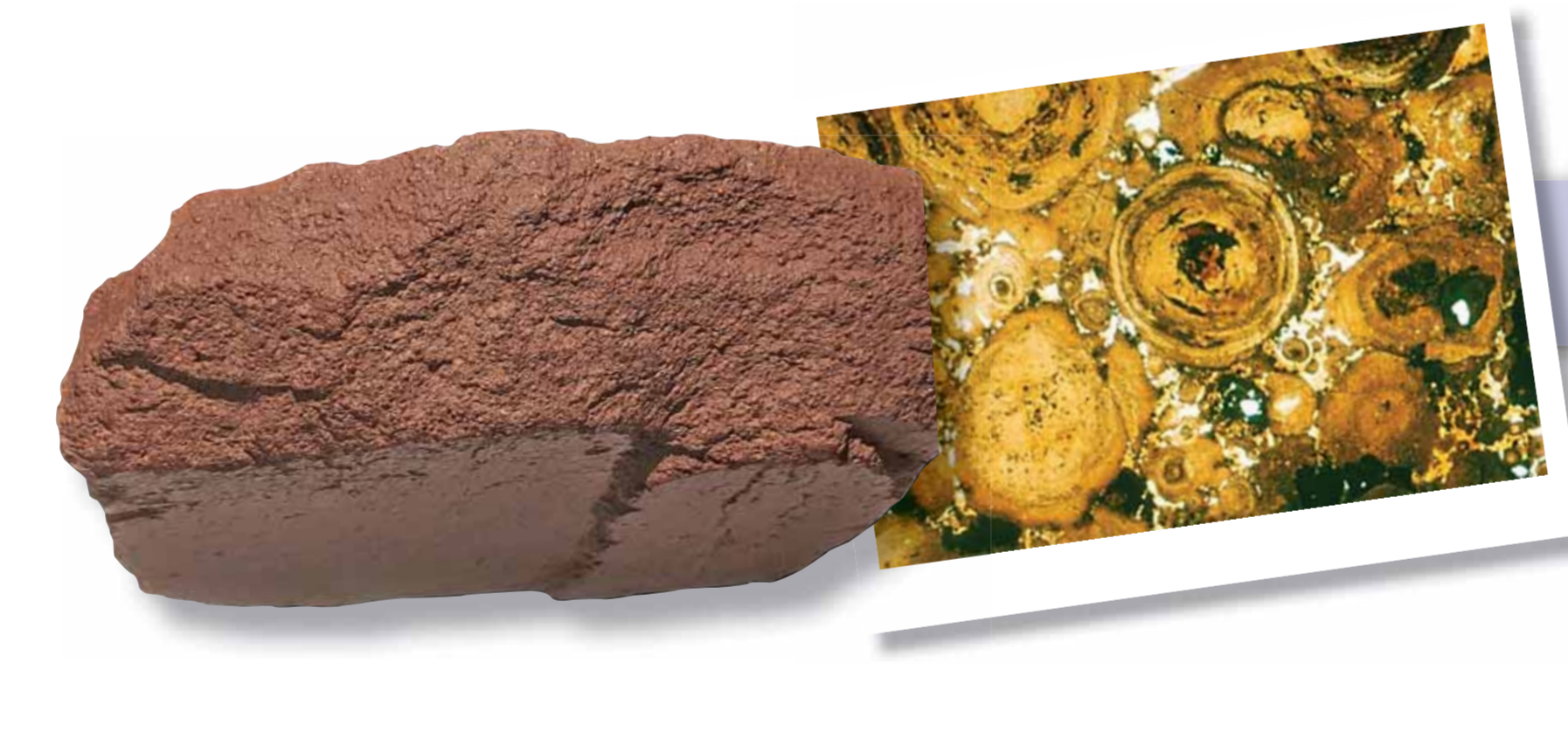
Origin of karst bauxites:

- (par)autochthonous (high-level karst; in situ processes predominate, vadose lithofacies)
- parallochthonous (sloping terrain; transitional)
- allochthonous (low-level karst; resedimentation, phreatic lithofacies)

#### Typically textures of karst bauxites:



pelitomorphic



oolitic



concretionary



pisolitic



elastic

### Mining, Metallurgy and Industry

Bauxite is the principal ore of aluminium and an important industrial mineral

Approximately 75% of all bauxites mined is used to produce aluminium metal by a two-stage process:

- 1) refining of bauxite to alumina by the Bayer process (a wet chemical caustic leach)
- 2) electrolytic reduction of alumina to aluminium metal by the Hall-Heroult process.

Gibbsitic bauxite are preferred over boehmitic bauxite and especially diasporic bauxite as it has lower energy requirements during Bayer process. When operating the Bayer process, highly alkaline waste (pH 10 - 13) known as red mud (up to 60% of iron oxides; silica; unleached residual aluminium and titanium oxide) is generated.

Bauxite is also world's main source of gallium. 25% of the bauxite is utilized as industrial mineral (chemical industry, cements, abrasives, proppants).

Bauxite has also been considered as a possible viable source of rare earth elements/critical metals (REE/CRM) for a long time.

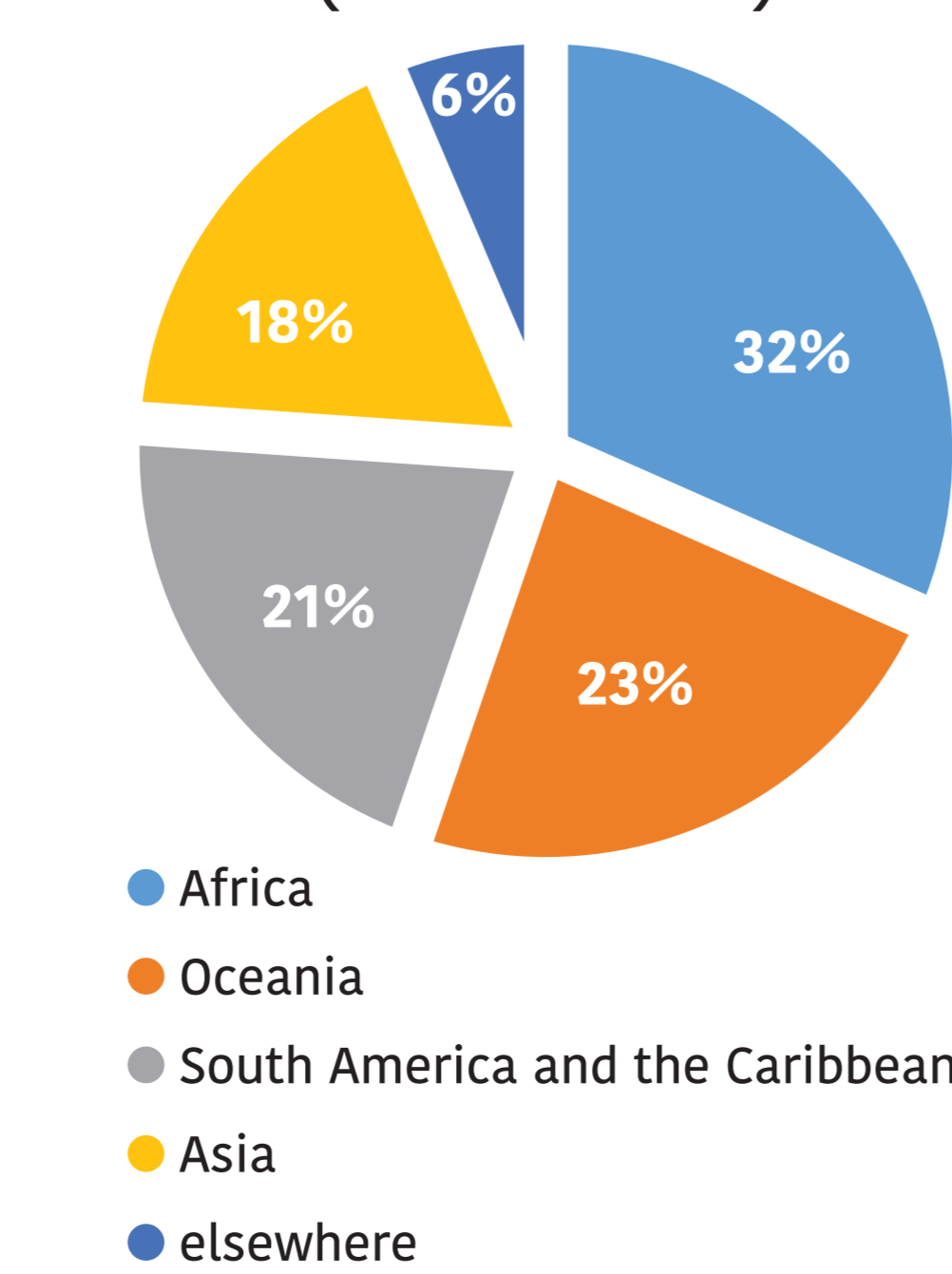
#### Production and reserves

More than 160 million metric tons of bauxite are mined each year. The majority of currently operating bauxite mines contain reserves in the range from 10 to 1000MT dry bauxite whereby ore grades vary between 40 and 55 wt.% available Al<sub>2</sub>O<sub>3</sub>. The leaders in bauxite production include Guinea, Australia, Vietnam, Brazil and Jamaica. For some bauxite producing countries such as Jamaica, Guyana, Guinea, and Suriname the potential bauxite value contributes to 10% and more of the country's GDP.

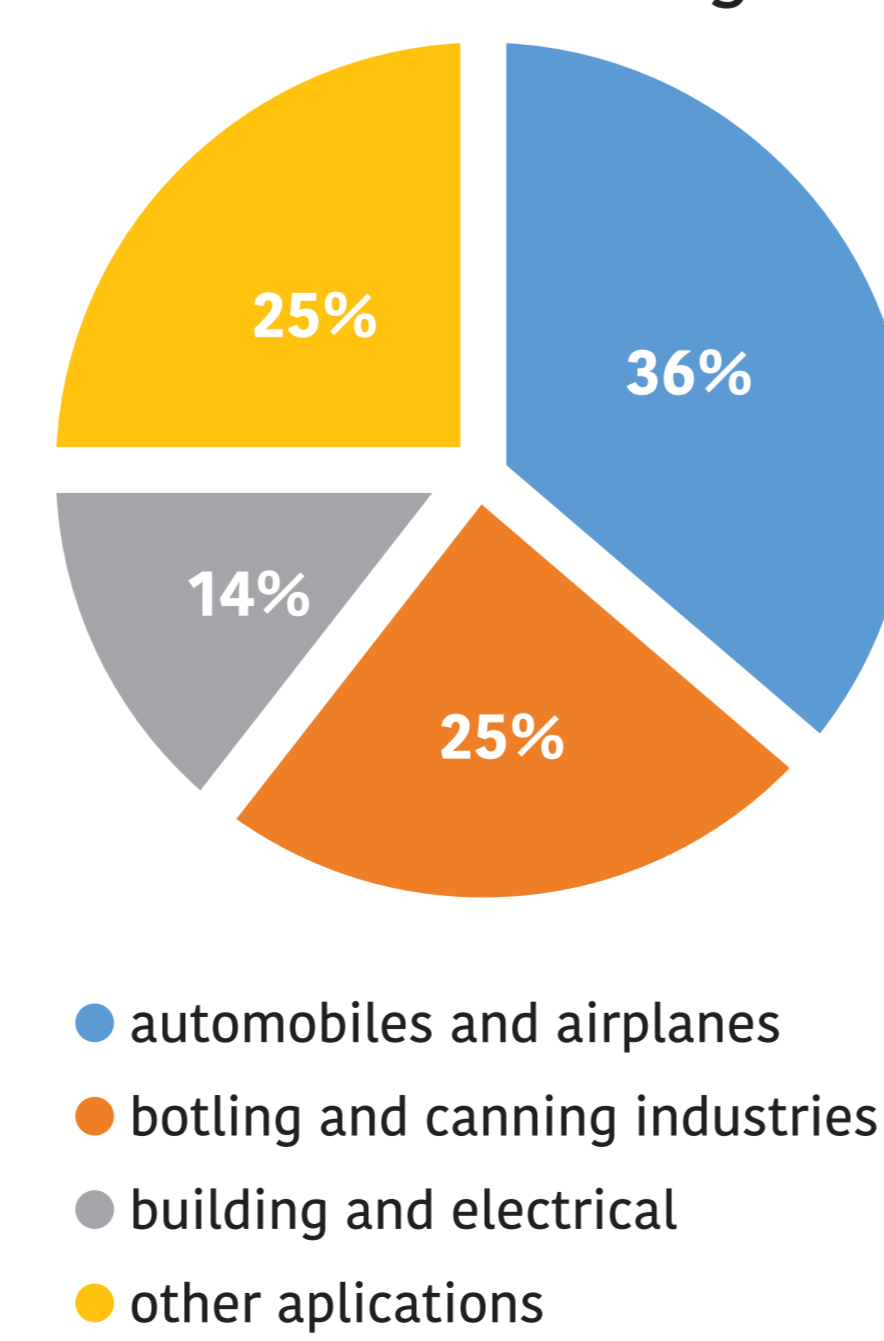
#### Aluminium

- most abundant metallic element in the Earth's crust
- most widely used metal after iron
- usually alloyed with copper, zinc, magnesium, manganese, or silicon to improve its mechanical properties, especially when tempered
- 100 percent recyclable and highly durable
- nearly 75% of all aluminium ever produced is still in use today
- recycling aluminium saves more than 90% of the energy needed to create a comparable amount of the metal from raw material

World bauxite resources in 2019 (est. 55-75 BT)



Aluminium usage



### Bauxites in Croatia

The area of the Croatian Karst (External or Outer) Dinarides is a thick carbonate succession deposited from the Middle Permian (or even Upper Carboniferous) to the Eocene on platforms of different ages, type and palaeogeographical setting. The models of the orogenic evolution of the Adriatic (Adriatic-Dinaric) Carbonate Platform (AdCP) with special reference to External Dinarides of the NE Adriatic region underlined the importance of numerous hiatuses (regional unconformities) of variable duration marked by bauxitic deposits.

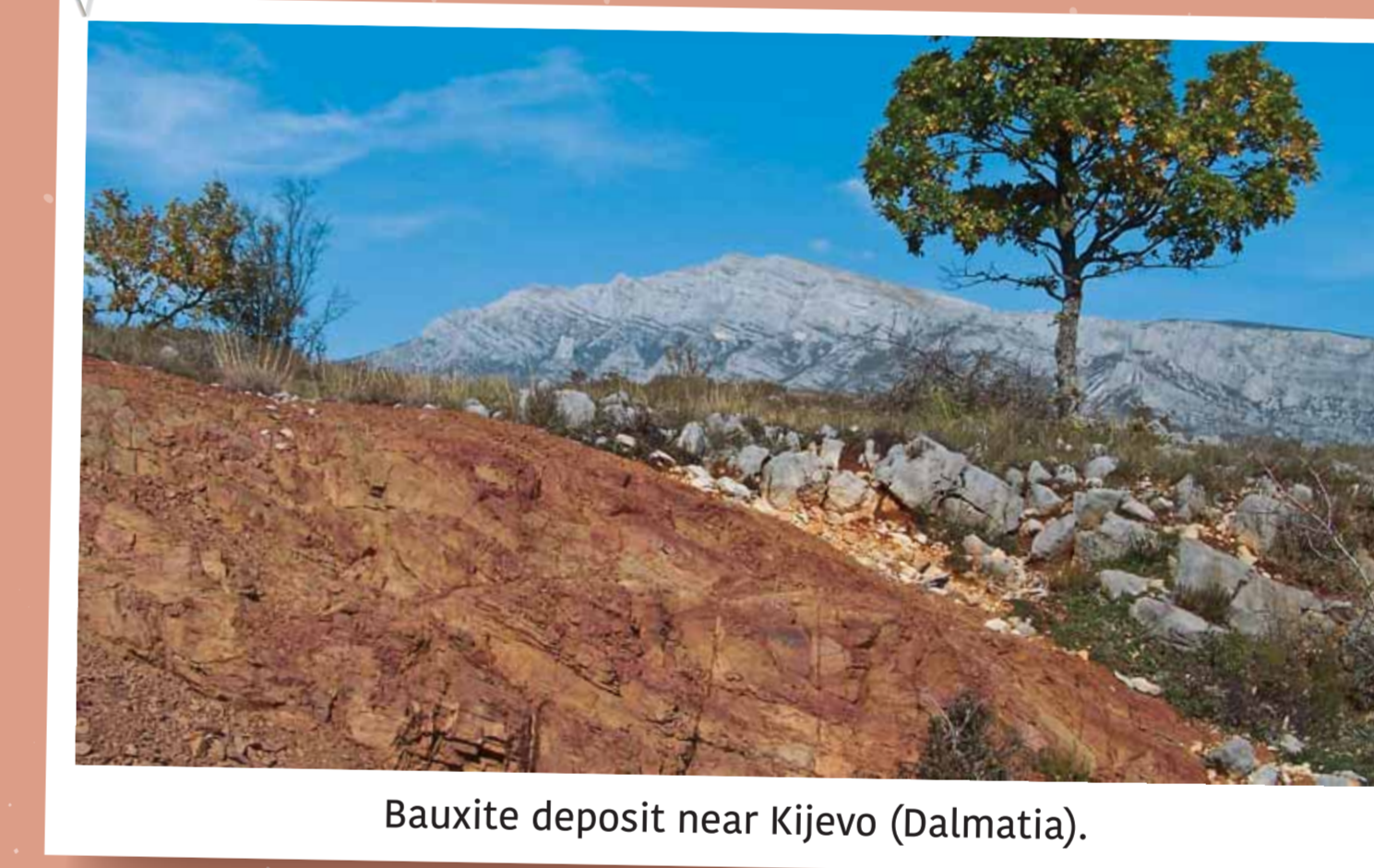
Bauxite deposits, hosted in carbonate rocks, are widespread and confirmed at numerous locations, in ten stratigraphic horizons from Middle Triassic to Miocene. They vary in their origin, age, size, and economical importance.

Neogene bauxite deposits are found in Karlovac County (Touj) and Dalmatia (Peruća, Trilj).



Upper Paleogene bauxites were formed during emersion caused by Pyrenean orogenic phase in Middle Eocene and were accumulated in the paleorelief of Upper Cretaceous and Lower Paleogene limestones, more rarely Kozina deposits. They are overlaid by transgressive Promina sediments, which were deposited during Middle and Upper Eocene as well as Lower Oligocene. They are found in the area of Obrovac, Drniš, Sinj and Imotski in Dalmatia.

Lower Paleogene bauxites were deposited after Laramian movements on paleorelief developed on the Upper Cretaceous limestones. They are found at numerous localities in Istria, along Northern Adriatic islands and in Dalmatia.

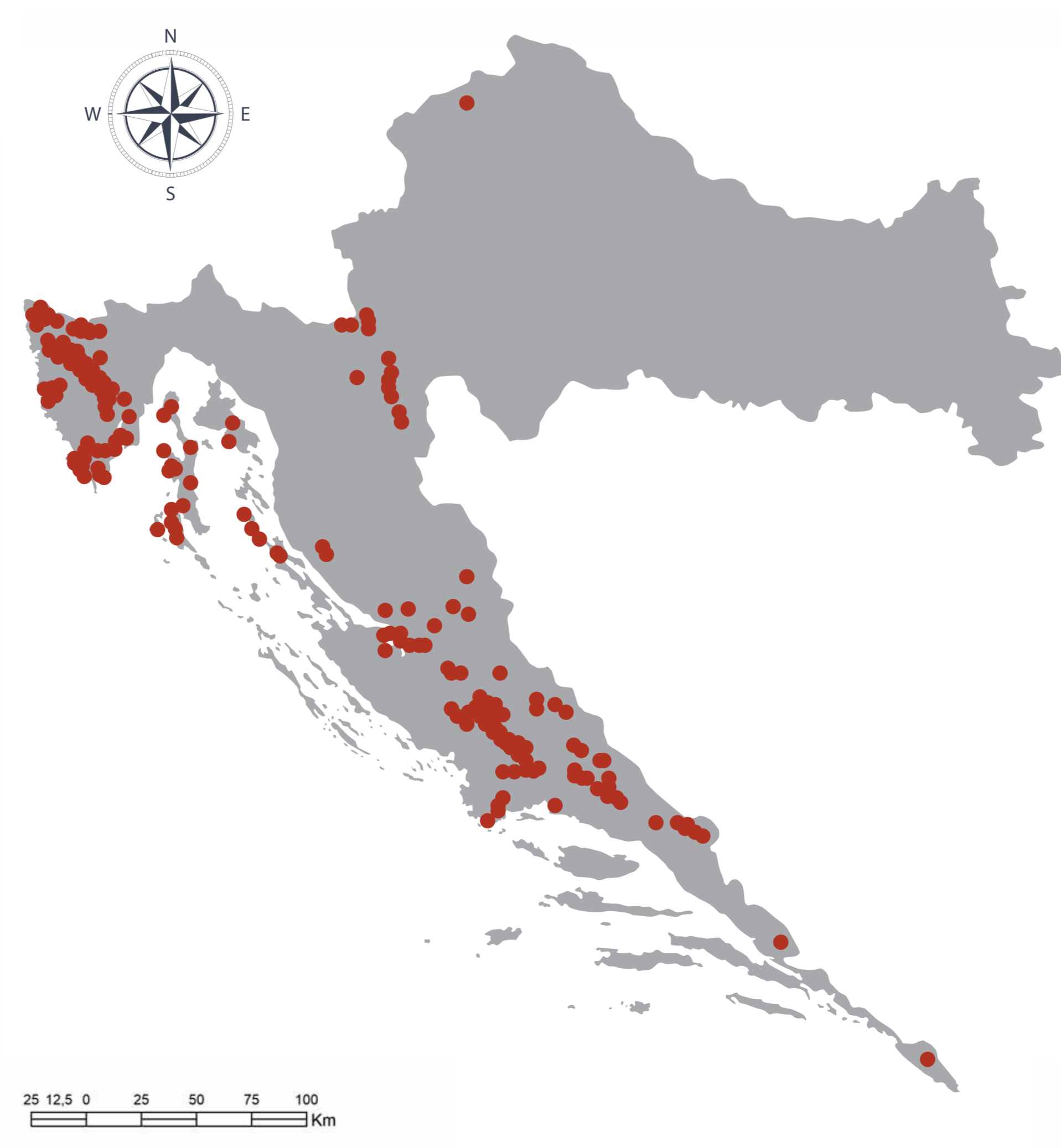


Cretaceous clayey bauxites (Early and Late Cretaceous) sporadically occur in Istria, along Northern Adriatic islands and Siljava and Dinara mountains (Early Cretaceous bauxites) and in the area of Karlovac County (Late Cretaceous bauxites).

Jurassic clayey bauxites occur at numerous localities in Istria.



Triassic deposits are considered to have formed by bauxitic processes in situ during emersion between Ladinian and Carnian age, which was related to the beginning of the Alpine orogeny. They are found in the Slunj area and Lika.



Other names for bauxites used in the present-day Croatia:

- Pyrite Aluminoso - Vetrivolica - named by Pietro Turini in 1780
- used as name for bauxite from 'Minjera' mine near Sovinjak in Istria
- Clachite - named by German mineralogist August Breithaupt in 1847
- after the Kfjaka bauxite deposit near Drniš

Interesting facts:

- The oldest bauxite mine in Europe is 'Minjera' near Sovinjak in Istria (mining started in 1560s)
- The deepest bauxite mine in the world in time of its closure (in 1963) was Kalun near Drniš in Dalmatia

Mining for aluminium industry, cements, abrasives, and bricks

- continuous mining for aluminium in period 1914 - 1990
- more than 1000 bauxite deposits were mined
- roughly 27.5 million tonnes of bauxite had been recovered
- over 800 open pits left (many are used as illegal waste disposal sites)
- 'Rovinj' in Istria is only active deposit (for cement industry)
- potentially contain significant concentrations of rare earth elements/critical metals (REE/CRM)