New Caledonia, a specific full size research laboratory to investigate lateritic Mining resources exploitation development, governance, impacts over the last century and to promote a new model for responsible mining

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Abstract

New Caledonia owns about 25% of the world's nickel resources, and around 9% of the world's reserves, distributed over 300,000 hectares of concessions allocated to date (18% of the total surface of the main island). Supergene weathering of ultramafic rocks have led to the genesis of lateritic nickel-rich ores of garnierite type (NiO> 1.5%) and / or iron oxi-hydroxide type (NiO <1.5%) under tropical lateritic conditions that have prevailed over 30 millions of years. These conditions have shaped the landscapes while offering Ni-rich regolith easy to exploit by open pit mining. Since 1880, nickel has been so far used as an economic driver and a societal development impetus. Since 1998, three worldwide projects have been developed, using pyrometallurgy (Ni-Si) and more recently hydrometallurgy (Ni-Fe) ore processes. However, natural erosion, anthropogenic disturbances (climate change, fires, urbanization, mining) can add up to disrupt the whole terrestrial and marine ecosystem functioning at the regional scale.This critical mined zone is covered by terrestrial ecosystems of great endemic biodiversity and adjoining a lagoon that has been listed as a UNESCO World Heritage Site in 2008. Such ecosystems are a valuable natural resource for the sustainable future for the next generations. Are mining and preserving ecosystems compatible, and for what economic and societal model? The conference reviews a collective research approach (mining, terrestrial and marine ecosystems impacts, restoration, biorecycling) to address this question. The corpus of acquired knowledge allows to propose an inclusive model of responsible mining activity, based on the "co-valorization" of both non-renewable and renewable primary resources through the development of circular economy and bio-economy principles, and applied all along the "mining ecosystem" project management. Considering i)the present day low GDP input of nickel mining in New Caledonia, the 98% dependency rate from fossil sources of energy, the CO2 emissions and the volatile Ni-market international context, this model, if followed, will reinforce the societal cohesion and develop a sustainable economy diversification, while enhancing energy transition and a better ecological efficiency.

New Caledonia: A specific full size research laboratory to investigate lateritic mining resources exploitation development, governanc impacts over the last century and to promote a new model for responsible mining

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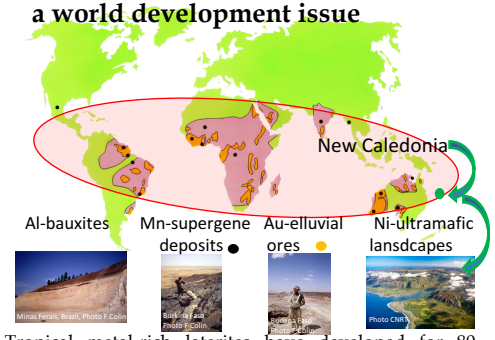
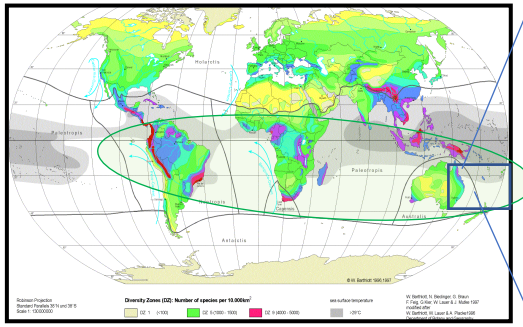
Global context: Conjugating mining production and biodiversity preservation: a world development issue

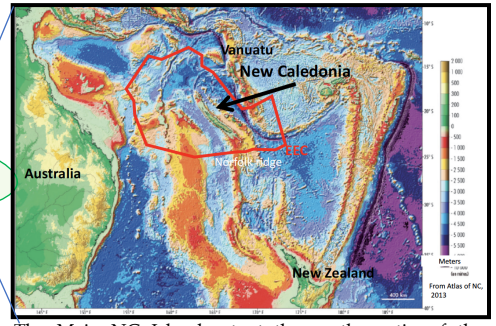


Tropical metal-rich laterites have developed for 80 Myears mostly at the expenses of primary rocks from Precambrian shields. These resources are future reserves for South countries developments.

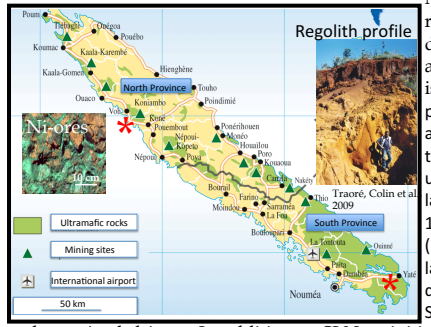


The tropical belt contains a wealth of biodiversity that is the humanity's sustainable reserve for the future. The biodiversity loss is increasing and inscribed these areas as biodiversity hot spots to be protected and preserved.

Geography, geology, and Ni-deposits of New caledonia

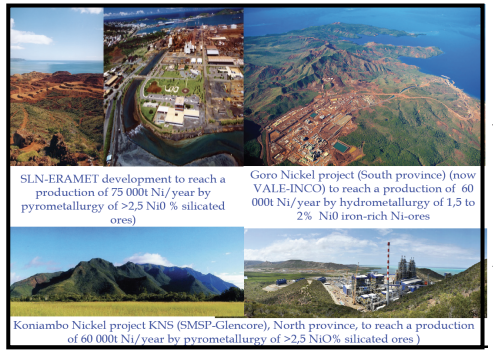


The Main NC Island set at the northern tip of the Norfolk ridge, both were rifted from the Australian margin during late Cretaceous. The ophiolitic units were obducted onto the Norfolk ridge 34 Myears ago.



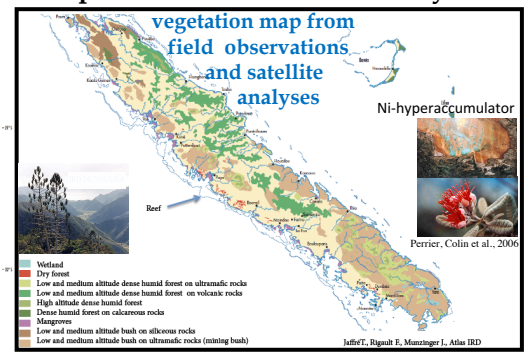
New Caledonia owns 25% of the world's nickel resources, around 9% of the world's reserves, distributed over 300,000 hectares of concessions allocated to date (18% of the surface of the main island). 1744 mining titles are attributed, 99% of the total produced Ni-ores has been extracted from concessions attributed before 1960 (4% of the NC surface). Low temperature alteration and supergene weathering of ultramafic rocks have led to the genesis of heterogeneous lateritic nickel-rich ores of i) green garnierite type (NiO> 1.5%) at depth and / or ii) surficial iron oxy- hydroxide type (NiO <1.5%). These conditions have shaped the NC landscapes (dissected plateau and lowlands) , offering 30m deep Ni-rich regoliths easy to exploit by open pit mining. Since 1880, nickel has been so far used as an economic and a societal driver. In addition to SLN activities, 2 new worldwide projects (*) have been developed since 1998, as a result of the political "Accord de Nouméa" between pluriethnic groups and to balance the economic development between Provinces, using pyrometallurgy (Ni-Si-ores)and hydrometallurgy (Ni-Fe-ores) processes.

Mining production objectives



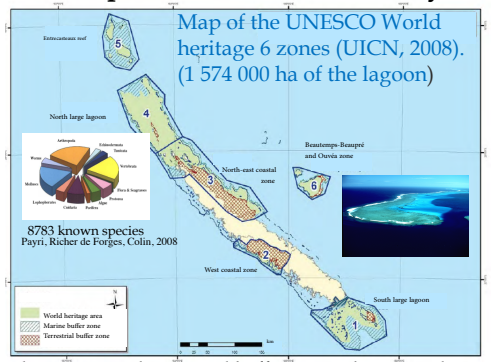
The objectives of the 3 main mining projects is to reach a production of 200 000 Nit/year in 2020.

Exceptional terrestrial biodiversity



80% of the terrestrial ecosystems species are endemic and mainly develop within ultramafic mining areas.

Exceptional marine biodiversity

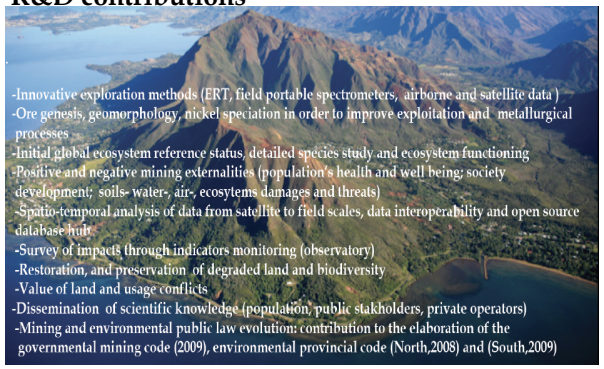


The marine and terrestrial buffer zone adjacent to the Goro-Vale mining project is included (zone 1)

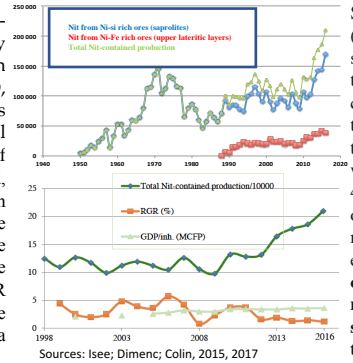
Environmental and societal on going impacts

Within the lateritic regolith, the circulation of waters is mainly controlled by two systems: 1) a surficial one, just under the iron crust, that feed locally the water springs, and 2) the water table at the weathering front of the parent rocks, that feed the rivers systems. The lateritic surficial formations are erosion-sensitive under natural climatic tropical events (lavakas, collapses, creepings), and anthropic disturbances (fires, urban development, mining activities) may accelerate the erosions rates as well (>1000 t/an/hectare) (Maurizot et al., in press). The water cycle can then be very rapidly affected. Mining activities may induce land and forest degradations and biodiversity losses, accelerate erosion of regoliths, provoque hypersedimentation in downslope rivers and lagoon, and disseminate metal trace elements through biosphere, hydrosphere and low atmosphere. At the present day 10,000 hectares of orphaned mines (0,6% of the total NC surface area) and 20000 hectares of degraded soils in active mine areas have to be restored, with a cost of 20,000 euros/ha. Populations leaving nearby may be positively impacted by employment, and negatively by land degradation, water quality decrease, rivers and lagoon contamination, that could affect directly their sustainable natural resources and their way of life in the future, while nickel ores are non renewable resource: **mining activities have to be lead responsibly**.

R&D contributions



The critical mining zone: an holistic full-size area investigated from the year 2002 by multidisciplinary research teams through public and private trust partnerships (IRD, UNC, BRGM, IAC-Cirad, I. Pasteur, Paris and Nancy School of mines, international collaborations). Then a tremendous increase of knowledge and skills acquisition has developed, inducing dedicated and appropriate decision support system towards public and private operators. This has contributed to improve the best practices of mining activities all along the life cycle of the mining projects included CSR developments, allowing a reduction of negative impacts, a better sharing of mine revenues, and a better social acceptability.



Sources: Isee; Dimenc; Colin, 2015, 2017

Since the year 1990, poorly surficial Ni-Fe ores are increasingly exploited (hydrometallurgy) and because these minerals are very extensive on the surface, its may induce very significant damages to ecosystems and disrupt the functioning of hydrosystems. In addition, from 2008 (world economic crisis) to present time, even if the GDP/inhab. remains constant, for the first time in its history, New Caledonia's real growth rate is inversely correlated to its nickel increasing production, to reach a very low rate of 2,5%. The Ni weight of nickel income in the total NC GDP reaches its lowest value of 4,5%. In addition, the production of CO_2 increase from 2008 at a annual rate of 4,5% due to the use of coal-fired power plants to produce the energy required for metallurgical power plants (8 MtCO2eq./y emitted = 30t of CO_2 eq./inhab./y.) **As a consequence, based on the knowledge intangible capital issued from research, we promote a new virtuous spiral model of mining activity, that will simultaneously permits to develop a sustainable diversified economy from natural renewable resources and to value the skills acquired (www.amedee-network.science).**