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Sedimentary records provide evidence of human induced environmental alterations in the coral reef lagoon of New Caledonia

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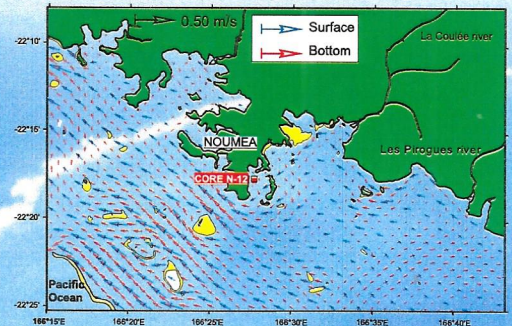
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Study site and Methods

Sediments have the potential for storing various information relative to past environmental conditions. Extracting and deciphering those natural archives are central to the understanding of past and present sedimentary processes and provide a dynamic view on the evolution of environmental conditions.

A 56 cm long sediment core was sampled in the Sainte Marie Bay (SW New Caledonia lagoon), cut in 2 cm thick slices and analysed for carbonate content, ^{210}Pb dating and metal concentrations. The analysis of Ni and Fe was conducted on 4 separate geochemical phases (oxidizable, acid soluble, reducible and refractory) according to Fernandez et al. (submitted). The sole results from the refractory phase are presented in this paper.

Location of the core N-12 in Sainte Marie bay



Results and Discussion

From the bottom to the top of the core, the joint decrease in carbonate and increase in refractory phase (top-left figure) provided first evidence of a progressive increase in terrigenous inputs.

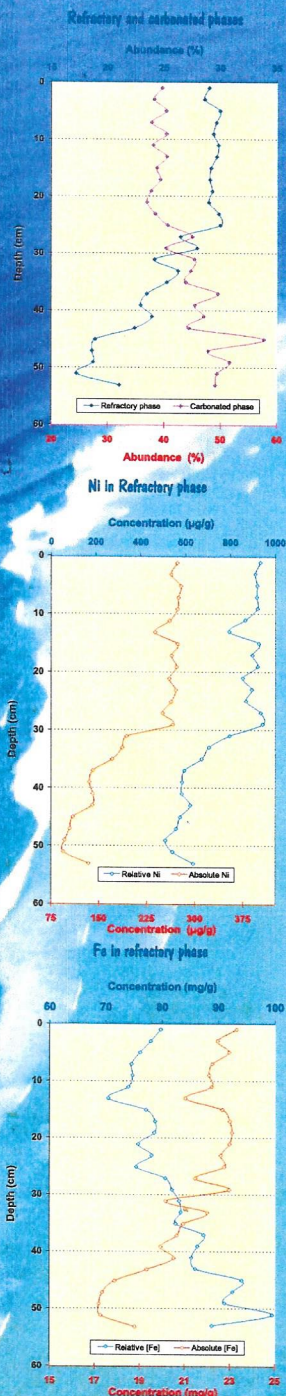
Profiles of Ni (middle-left figure) and Fe (bottom-left figure) in the refractory phase versus depth corresponded to:

- 1) concentrations per mass unit of grain size fraction below $40\ \mu\text{m}$ referred to as "absolute" concentrations (plotted in red).
- 2) concentrations per mass unit of refractory phase in the grain size fraction below $40\ \mu\text{m}$ referred as "relative" concentrations (plotted in blue).

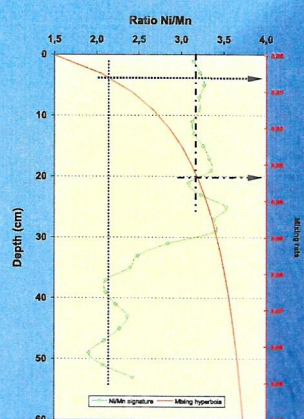
From the bottom to the top of the core, we observed a 33% increase in "absolute" Fe together with a decrease in "relative" Fe. Concurrently, "absolute Ni" was multiplied by 7 from the bottom ($80\ \mu\text{g g}^{-1}$) to the top ($580\ \mu\text{g g}^{-1}$) of the core and "relative" Ni increased from $600\ \mu\text{g g}^{-1}$ to $950\ \mu\text{g g}^{-1}$. This pattern strongly suggests an increase in the deposition of sediment depleted in Fe and enriched in Ni, such a signature is typical of the mineral particulate matter originating from the adjacent rivers.

The shift in Ni/Mn ratio (below-left) from 2.2 at the core base to 3.3 at the top of the core is consistent with an increase in soil erosion delivered by La Coulée and Les Pirogues river catchments. Using a simple mixing model and assuming the source material to be insignificantly modified by chemical processes, it was possible to link the geochemical composition of the deposited sediment with the Ni/Mn signature of the terrigenous sources. The mixing hyperbola demonstrated that the contribution from the 2 main rivers was multiplied by 3 in the top 30 cm layer.

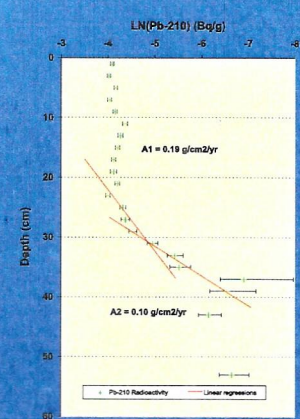
Results from ^{210}Pb (below-right) revealed that beyond a significant bioturbation layer extending down to 20 cm depth, two average accumulation rates were calculated. The respective sediment accumulation rates were $0.2\ \text{g cm}^{-2}\ \text{yr}^{-1}$ between 20 and 30 cm and $0.1\ \text{g cm}^{-2}\ \text{yr}^{-1}$ below 30 cm. The shift in sedimentation rate corresponded with the geochemical changes recorded in the core and when applying the higher accumulation rate to the whole 30 cm top layer it was dated at $1945 \pm 5\ \text{yr}$.



Coulée and Pirogues rivers input



Excess Pb-210 Activity



Conclusion

Changes in sediment accumulation rates and geochemical composition in the middle of the 20th Century corresponded with the beginning of open-cast mining and deforestation in the southern part of the island. Due to subsequent additional erosion terrigenous material has been delivered to the coastal zone, significantly affecting sediment deposition in Sainte Marie Bay, more than 11 km away from the nearest river source. Joint quantitative (accumulation rates) and qualitative (metal composition) modifications of the inputs at the water-sediment interface were demonstrated. However, metals do not provide a precise enough signature to identify each river sources and additional work is currently investigating the use of Rare Earth Elements signatures.