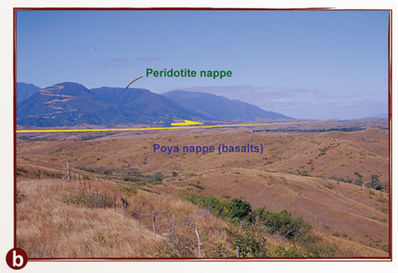
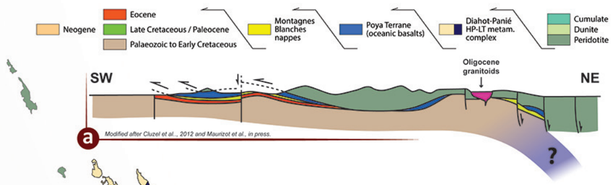
Multi-scale **Onland-Offshore** Investigations of the **New Caledonia Ophiolite**, SW Pacific

Clerc C.[1], Collot J.[2], Sevin B.[2], Patriat M.[3], Etienne S.[2,4], Iseppi M.[1], Lesimple S.[2], Jeanpert J.[2], Mortimer N.[5], Robineau B.[2], Poli S.[2,3,4], Cluzel D.[1], Pattier F.[3], Juan C.[2], Godard M.[6]

(1) Université de la Nouvelle-Calédonie, ISEA, Nouméa, New Caledonia. (2) DIMENC, Geological Survey of New Caledonia, Nouméa, New Caledonia. (3) IFREMER, Plouzané, France. (4) DIMENC - ADECAL Technopole, Nouméa, New Caledonia. (5) GNS Science, Dunedin, New Zealand. (6) Géosciences Montpellier, Montpellier, France.

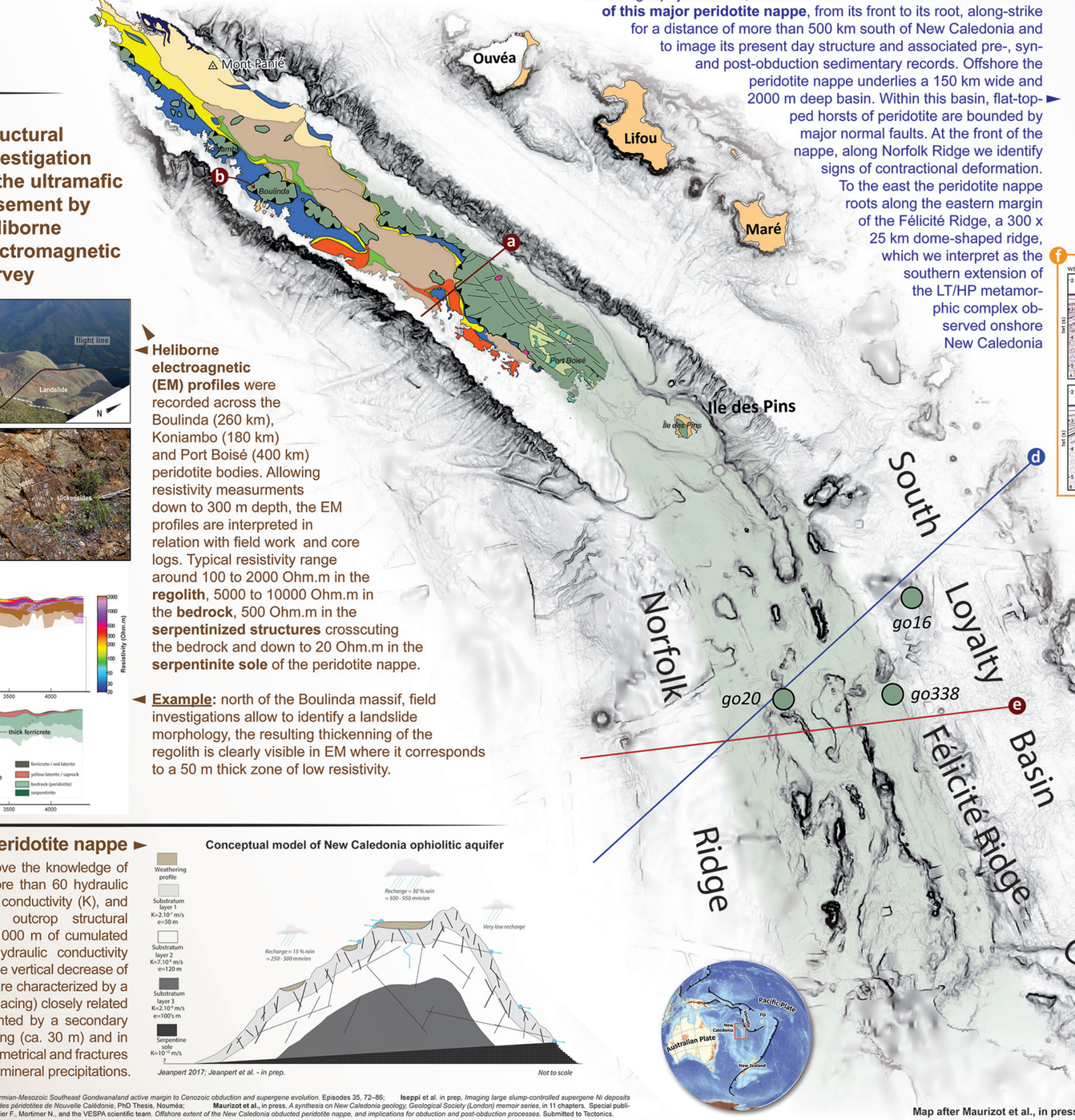
One of the largest ophiolitic peridotite masses in the world covers a quarter of the 500 x 80 km island of Grande Terre, New Caledonia. This massive thrust sheet was obducted during the Eocene, is weakly deformed and is the highest of a structurally simple pile of thrust nappes.

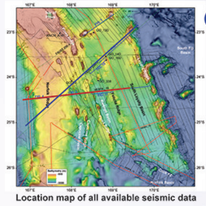


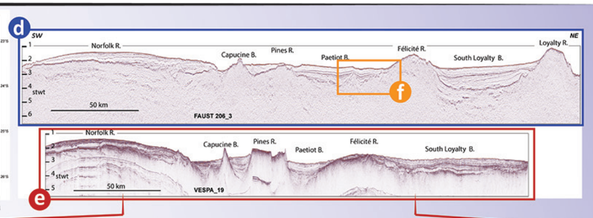


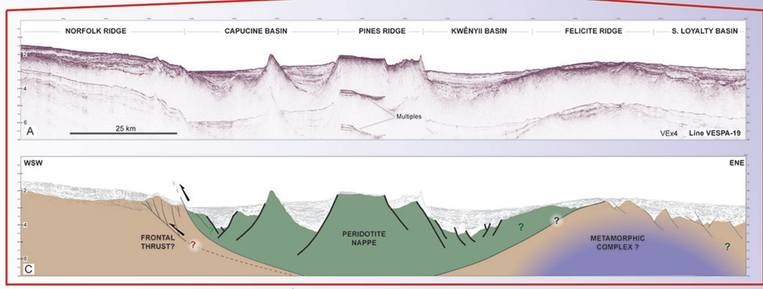
Offshore extension of the peridotite nappe

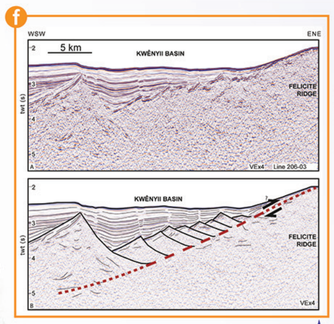
We present new marine seismic data which, combined with existing geological and geophysical data, allows us to track the **offshore continuation of this major peridotite nappe**, from its front to its root, along-strike for a distance of more than 500 km south of New Caledonia and to image its present day structure and associated pre-, syn- and post-obduction sedimentary records. Offshore the peridotite nappe underlies a 150 km wide and 2000 m deep basin. Within this basin, flat-topped horsts of peridotite are bounded by major normal faults. At the front of the nappe, along Norfolk Ridge we identify signs of contractional deformation. To the east the peridotite nappe roots along the eastern margin of the Félicité Ridge, a 300 x 25 km dome-shaped ridge, which we interpret as the southern extension of the LT/HP metamorphic complex observed onshore New Caledonia





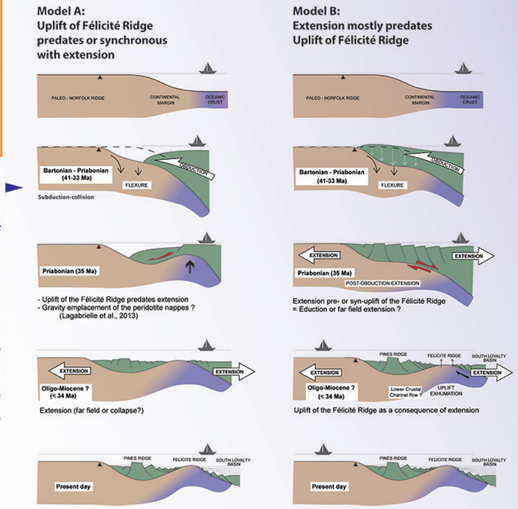




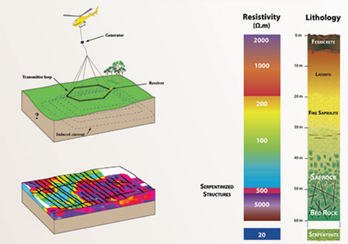


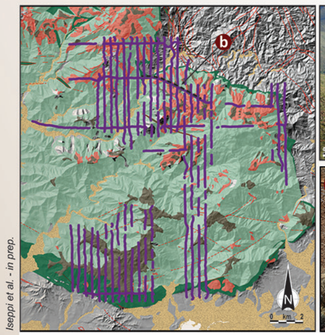
The **offshore extension of the obducted peridotite nappe** is now identified S and SSE of New Caledonia. Evidence is based on a few dredged samples and by characteristic high amplitude seismic reflections resulting from the strong impedance contrast between the sediments and the peridotites . The peridotite nappe is **cut by undisputable normal faults** associated with **post-obduction extension**.

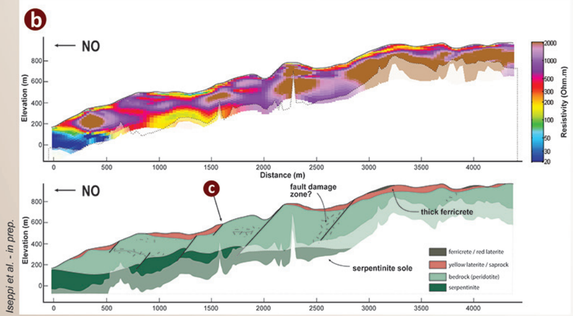
Because the relative timing between the extension phase and the uplift of the Félicité Ridge is poorly constrained, we propose **two alternative models of obduction to post-obduction evolution.**



Structural investigation of the ultramafic basement by Heliborne electromagnetic survey







Heliborne electroagnetic (EM) profiles were recorded across the Boulinda (260 km), Koniambo (180 km) and Port Boisé (400 km) peridotite bodies. Allowing resistivity measurments down to 300 m depth, the EM profiles are interpreted in relation with field work and core logs. Typical resistivity range around 100 to 2000 Ohm.m in the **regolith**, 5000 to 10000 Ohm.m in the **bedrock**, 500 Ohm.m in the **serpentinized structures** crosscuting the bedrock and down to 20 Ohm.m in the **serpentinite sole** of the peridotite nappe.

Example: north of the Boulinda massif, field investigations allow to identify a landslide morphology, the resulting thickenning of the regolith is clearly visible in EM where it corresponds to a 50 m thick zone of low resistivity.

Hydrologeological structure of the peridotite nappe

New Caledonia offers unique opportunities to improve the knowledge of **ultramafic hydrosystems in tropical climate**. More than 60 hydraulic tests were performed to determine mean hydraulic conductivity (K), and fracture network analysis were derived from outcrop structural measurements and from the description of about 1000 m of cumulated borehole cores. The observations reveal that hydraulic conductivity decreases with depth within the substratum, due to the vertical decrease of weathered fractures density. The peridotite massifs are characterized by a primary decimetrical fracture network (20 – 30 cm spacing) closely related to the serpentine network. This network is overprinted by a secondary weathering network which reveals decametric spacing (ca. 30 m) and in places K values of 10^{-5} m/s. At depth, spacing is hectometrical and fractures are sealed by lithostatic pressure and/or subsequent mineral precipitations.

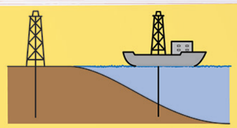
Conceptual model of New Caledonia ophiolitic aquifer

References:

Cluzel, D., Maurizot, P., Collot, J., Sevin, B., 2012. *An outline of the Geology of New Caledonia; from Permian-Mesozoic Southeast Gondwanaland active margin to Cenozoic obduction and supergene evolution.* Episodes 35, 72–86; **Iseppi et al.** in prep, *Imaging large slump-controlled supergene Ni deposits by heliborne eletromagnetic surveys;* **Jeanpert,** 2017, *Structure et fonctionnement hydrogéologique des péridotites de Nouvelle Calédonie,* PhD Thesis, Nouméa; **Maurizot et al.,** in press, *A synthesis on New Caledonia geology. Geological Society (London) memoir series,* in 11 chapters. Special publications of Geological Society of London: **Patriat, M.,** Collot J., Etienne S., Poli S., Juan C., Clerc C., Pattier F., Mortimer N., and the VESPA scientific team. *Offshore extent of the New Caledonia obducted peridotite nappe, and implications for obduction and post-obduction processes.* Submitted to Tectonics.

Map after Maurizot et al., in press and Patriat et al., in revision

An Amphibious IODP - ICDP project



The New Caleonian Ophiolite is one of the largest obducted peridotitic masses in the world. An Amphibious Drilling Proposal will provide a more complete understanding of an obducted deep geological system from a terrestrial setting to its marine extension, which is as close as possible to its unobducted mantle lithosphere source. Drilling onshore and offshore along the New Caledonia ophiolite would allow emplacement mechanisms of mantle-dominated allochthons to be assessed, as well as constraining high and low temperature alteration processes. Other objectives could relate to studying archaeal and eubacterial communities that are known to develop in these alkaline systems, while the formation of the world's second largest rimmed carbonate reefs during the Miocene to Quaternary could be investigated.