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DEEP SUBMERSIBLE DIVES AT THE D'ENTRECASTEAUX - NEW HEBRIDES ARC COLLISION ZONE, VANUATU

(The French SUBPSO Expedition with Nadir/Nautile 27 February to 13 March 1989)

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INTRODUCTION

Nadir sailed 1000 February 27 from Noumea, New Caledonia arriving at the first dive sites offshore Espiritu Santo Island in Vanuatu during the morning of March 2, 1989. Seven dives were made by Nautile to explore the d'Entrecasteaux - New Hebrides Arc Collision Zone in preparation for ODP drilling (Figure 1).

BACKGROUND

The d'Entrecasteaux Zone (DEZ) is a submarine chain of seamounts and ridges that extend from the northern New Caledonia ridge to the New Hebrides subduction zone. This chain has been colliding with the central New Hebrides Island Arc for the past 8-6 my. The DEZ trends slightly oblique to the plate convergence direction of N76'E so that it has a component of northward movement along the New Hebrides Trench at 2.5 cm/yr.

SCIENTIFIC PARTICIPANTS

Jacques Daniel	ORSTOM, Noumea - Chief Scientist
Jean Boulin	University of Marseille - Structural Geologist Dive 6
Jean-Yves Collot	ORSTOM/USGS Menlo Park - Geophysicist Dive 1
Jean Philippe Eissen	ORSTOM Noumea - Petrologist Dive 3
Mike Fisher	USGS Menlo Park - Geophysicist Dive 2
Gary Greene	USGS Menlo Park - Marine Geologist Dive 4
Serge Lallemaud	University of Paris - Structural Geologist Dive 5
Michel Monzier	ORSTOM Noumea - Geologist
Bernard Pelletier	ORSTOM Noumea - Structural Geologist Dive 7

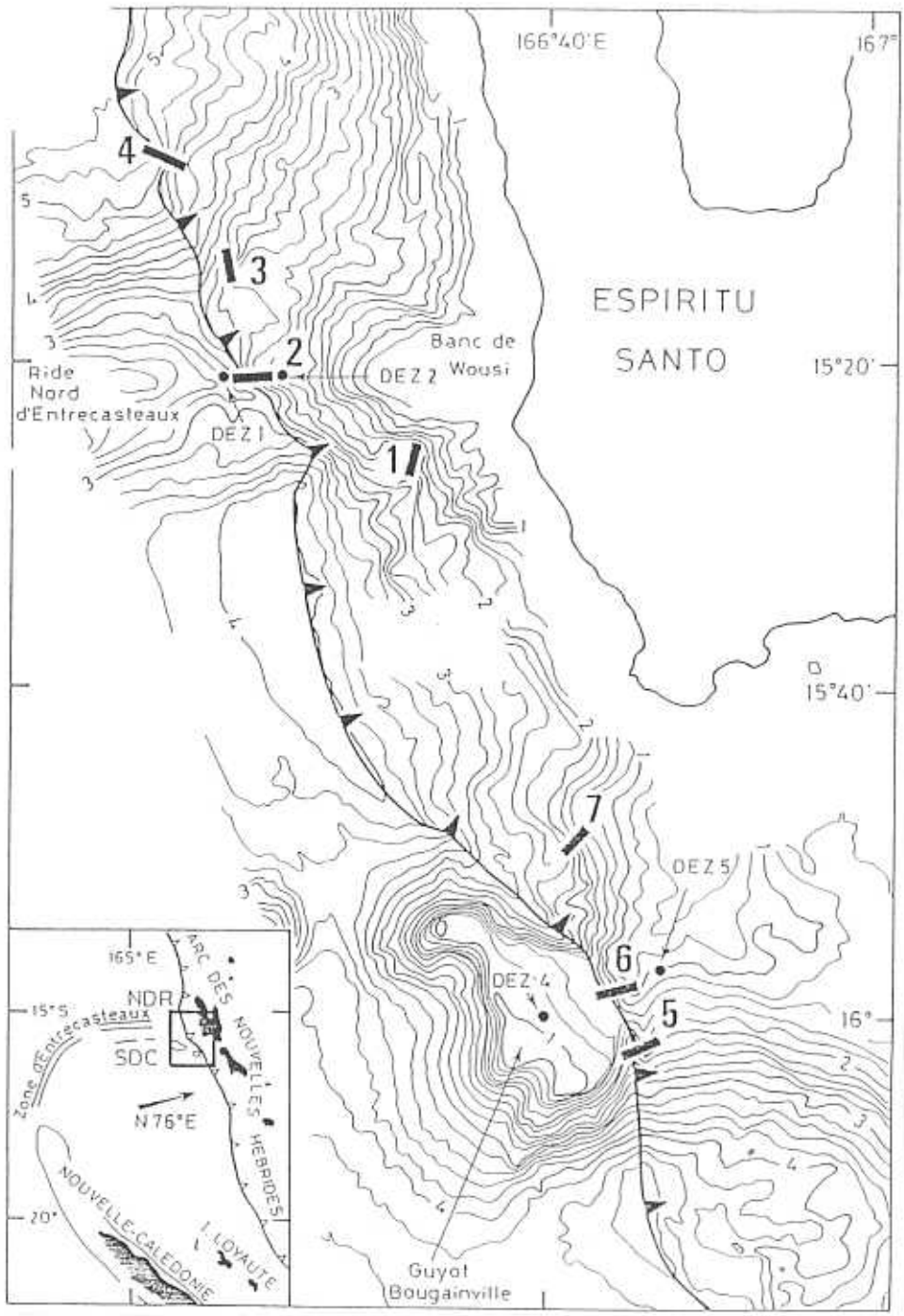
166°40'E
167°
ESPIRITU
SANTO
15°20'
15°40'
16°
Banc de
Wousi
DEZ 2
DEZ 1
Ride
Nord
d'Entrecasteaux
DEZ 5
DEZ 4
Guyot
Bougainville
1
2
3
4
5
6
7
165°E
15°S
20°
NDR
SDC
N76°E
ARC DES NOUVELLES HEBRIDES
Zone d'Entrecasteaux
NOUVELLE-CALEDONIE
I. LOYAUTE

Figure 1.

OBSERVATIONS

Four dives were made along the flanks of Wousi Bank, a distorted forearc area where the North d'Entrecasteaux Ridge (NDR) of the DEZ is colliding with the arc (Figure 2). Three dives were made along the flanks of the Bouganville Guyot, a subducting guyot of the South d'Entrecasteaux chain (SDC) of seamounts of the DEZ (Figure 2).

Dives made along the flanks of Wousi Bank (March 2-6) were in an area where detailed Seabeam data show that the oblique collision of the NDR has produced an asymmetric structural pattern characterized by N-NW verging thrust faults and N120'E trenching strike-slip faults. (Collot,, et al, in press). Observations from Nautile indicate that the upper part of the slope here is composed of basaltic to andesitic lavas interbedded with coarse to fine grained volcanoclastic rocks that dip 20' to 40' NE (Figure 2). The toe of the arc slope is blanked with cohesive greenish mud and the deformation front is marked by a 1-2 m high scarp composed of indurated mud. Along a north facing scarp, 4 km east of the deformation front, the arc slope shows a series of tuffoceous sandstone outcrop, intercalated with reddish-brown clay or mudstone. Structurally the lithologic units identified from the submersible dip 20' to 40' NE along the upper slope and 40' to 70' NE to E at the toe of the slope near the deformation scarp. Well developed subvertical fractures trenching N 110' to 140' in the upper slope areas and shearing, often parallel to bedding, were observed. The lower arc slope exhibits a very rough morphology, in places badland like, with prominent slump scars, gullies, high relief canyons, and in one place a scour hole. This morphology was evidently produced by scouring from turbidity flows from a small submarine canyon upslope. This canyon has been cut off by the deformation front. The observed morphology at the depth of nearly 5,000 m is characteristic of that formed by streams onland.

Three dives (March 8-10) were made along the flanks of the Bouganville Guyot, an andesitic edifice capped with 800 m of carbonates and tilted 4' arcward. The guyot indents the arc slope and its collision with the New Hebrides Arc has formed a ridge on the forearc that rises above the guyot. The contact zone between the guyot carbonate platform and the ridge on the arc slope is a 400 m wide depression, draped with sandy mud. Along the SE flank of the guyot, the contact zone is formed by a 10 m wide, flat bottomed canyon covered with fine grained sediment. No teutonic deformation was observed in the contact zone. Observations made along the arc slope above this collision zone delineated a steep (25' - 45') west dipping slope with badland like morphology, incised with many slump scars and gullies. Graywackes, tuffs, tufaceous limestones, volcanic breccias, and

brecciated lava flows are present here and these units range in attitude from 10' - 50' E to 20' - 40'W to SW (Figure 2).

The volcanic and volcanoclastic rocks of the DEZ collision zone, their structural configuration, and lithologies similar to the arc slope and islands suggest that rocks forming the surficial parts come from the arc. The impact of the NDR at the subduction zone appears to have formed a tectonic wedge and deformation front from lateral thrust. Along the lower flanks of Bougainville guyot the deformation observed suggests that during the subduction of the guyot the decollement migrated upward in the arc slope rock to reach the roof of the guyot. No evidence of fluid venting was observed.

The dives were terminated prematurely due to hydraulic failure of the A-frame on March 11. The Nadir returned to Noumea for repairs, arriving in port March 13.

CONCLUSIONS

Overall the cruise was very successful. Many new facts were discovered through the observations of Nautile. Precision stratigraphic sampling and photographic transects were made and these data are presently being analyzed. The analysis will provide age and other information useful in determining where the rocks came from and how they were emplaced. The dives were invaluable in evaluating the area for ODP drilling. It became apparent during the dives that thick (< 1200 m) unconsolidated rocks exist that will allow the drill stem to be spudded in the vicinity of the proposed Leg 134 drill sites at DEZ 1 and 2.

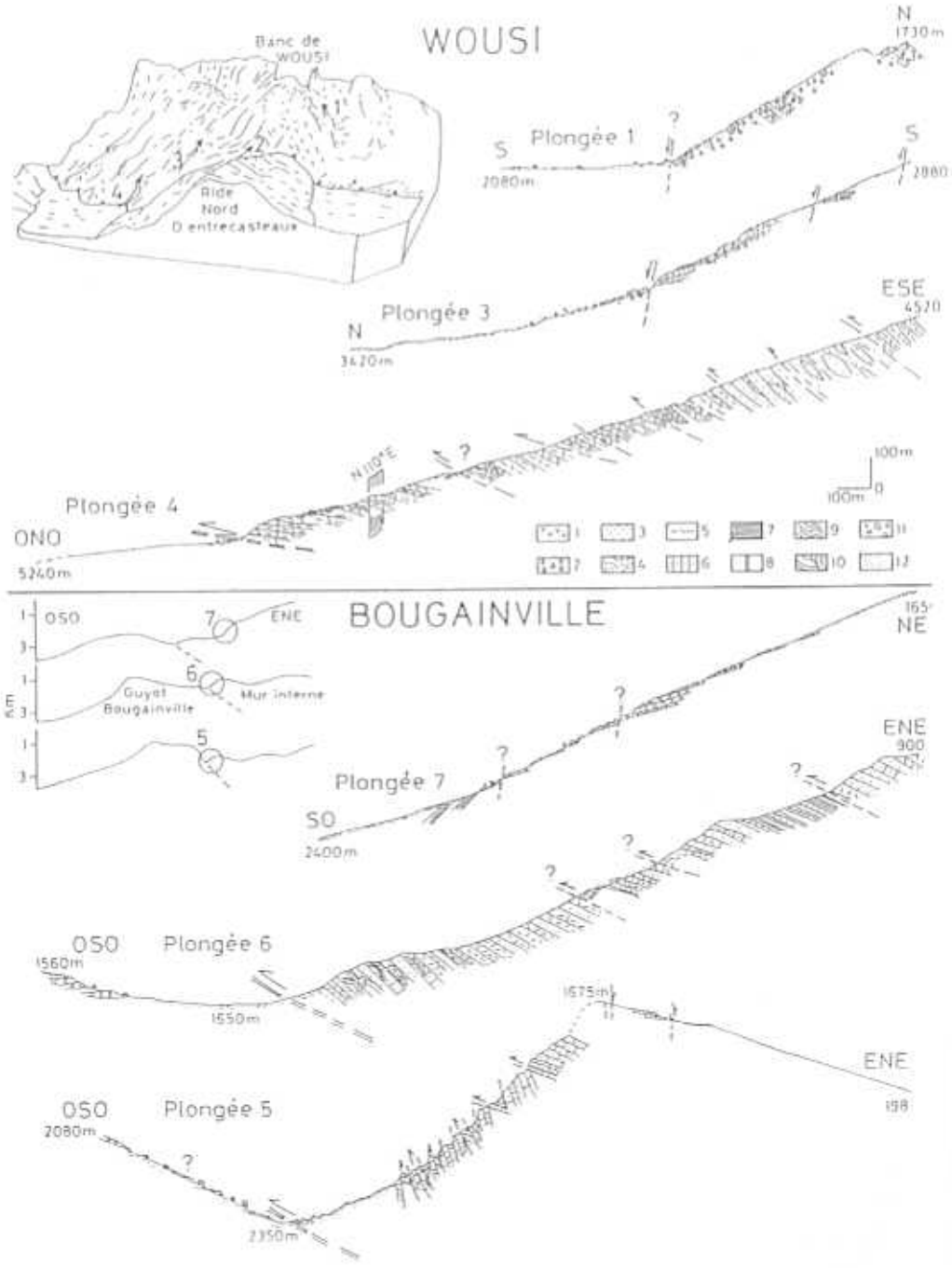
WOUSI
Banc de WOUSI
Ride Nord D'entrecasteaux
N
1730m
S
Plongée 1
2080m
S
2080
Plongée 3
N
3420m
ESE
4520
Plongée 4
ONO
5240m
100m
0
BOUGAINVILLE
OSO
ENE
Guyot Bougainville
Mur interne
Plongée 7
SO
2400m
NE
ENE
900
OSO
Plongée 6
1560m
1650m
1675m
ENE
OSO
Plongée 5
2080m
2350m

Figure 2.

REFERENCE

COLLOT, J.Y.; FISHER, M.A. (in press): The collision between the north D'Entrecasteaux Ridge and the New Hebrides Island Arc, Part 1: SEABEAM morphology and shallow structure.