

POLYPHASIC TERTIARY TECTONICS OF THE INTERIOR RANGE IN THE CENTRAL PART OF THE WESTERN CARIBBEAN CHAIN, GUARICO STATE, NORTHERN VENEZUELA

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ABSTRACT

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The southern -non metamorphic- belt of the Western Caribbean Chain is composed of the superposition of several tectonic units with an upper Cretaceous-Palaeocene content. The whole -called 'Piemontine Nappe'- was detached from an Albian and pre-Albian substratum and suffered two major compressive tectonic phases with southward displacements. The first phase -lower Middle Eocene- produced the allochthony of the previously tectonized Villa de Cura Nappe, which was strongly shortened. During the Oligocene (?) -Miocene period, a wide subsiding furrow appeared along the southern margin of the palaeorelief formed before in relation with a NNW-SSE distension. The second tangential phase -Middle-Upper Miocene- produced a partial overthrusting of the Piemontine Nappe on the Miocene terrains and a new shortening of the latter. An earlier phase may have affected the northern part of the Piemontine dominion in the lower Senonian. This hypothesis and the preceding conclusions are in opposition with the theory -generally held- of a displacement of the Villa de Cura Nappe as due to a continuous sliding occurring during Maastrichtian and Palaeocene time and followed by a continuous sliding of the Piemontine Nappe from Upper Eocene to Miocene time. The hypothesis of tectonisation by gravity sliding is discussed and discarded.

INTRODUCTION

The southern branch of the Caribbean alpine system (AUBOUIN ET AL., 1977) corresponds to the Caribbean Chain *sensu stricto* or Caribbean Mountain System (BELLIZZIA, 1972) that stretches over the entire northern edge of Venezuela and extends eastward into Trinidad (Fig. 1). Only the Western Caribbean Chain (BELLIZZIA, 1972) will be considered here; it includes from north to south (Fig. 1):

(1) A vast heterogeneous, polytectonized and metamorphosed set of upper Jurassic-Cretaceous age, and made of several parallel belts stretched east-west (MENENDEZ, 1966; BELLIZZIA, 1972). The more southern -the Villa de Cura Belt- is made of metamorphosed basic volcanic rocks of lower Cretaceous age (PIBURN, 1968). It overthrusts -in the south- the Piemontine Nappe (BELL, 1968; GONZALEZ SILVA & PICARD, 1972), which is the subject of this paper.

(2) A non-metamorphic belt (Foothills Belt of PEIRSON, 1965; BELL, 1968, 1971) called here Piemontine Nappe (BECK, 1977 a, b) mainly composed of siliceous-limy upper Cretaceous covered by thick Palaeocene-lower Eocene in a typical flysch facies (PEIRSON ET AL., 1966).

The Piemontine Nappe is partially overthrust -to the south- on the molassic sediments of the Miocene Guarico Basin. They are separated by a narrow 'Frontal thrust-sheets Zone' (BECK, 1977a, b) corresponding to both the 'Chacual Complex' and the 'Reversed Belt' of PEIRSON (1965).

FROM THE SOUTHERN EDGE OF THE VILLA DE CURA NAPPE TO THE UNDEFORMED MIO-PLIOCENE OF THE GUARICO PLAIN

The structure and the stratigraphy of the studied area are summarized respectively on figure 2 and on figure 3; the cross-sections a and b are indicated on figure 1.

The Piemontine Nappe

This is an allochthonous set, strongly folded and faulted,

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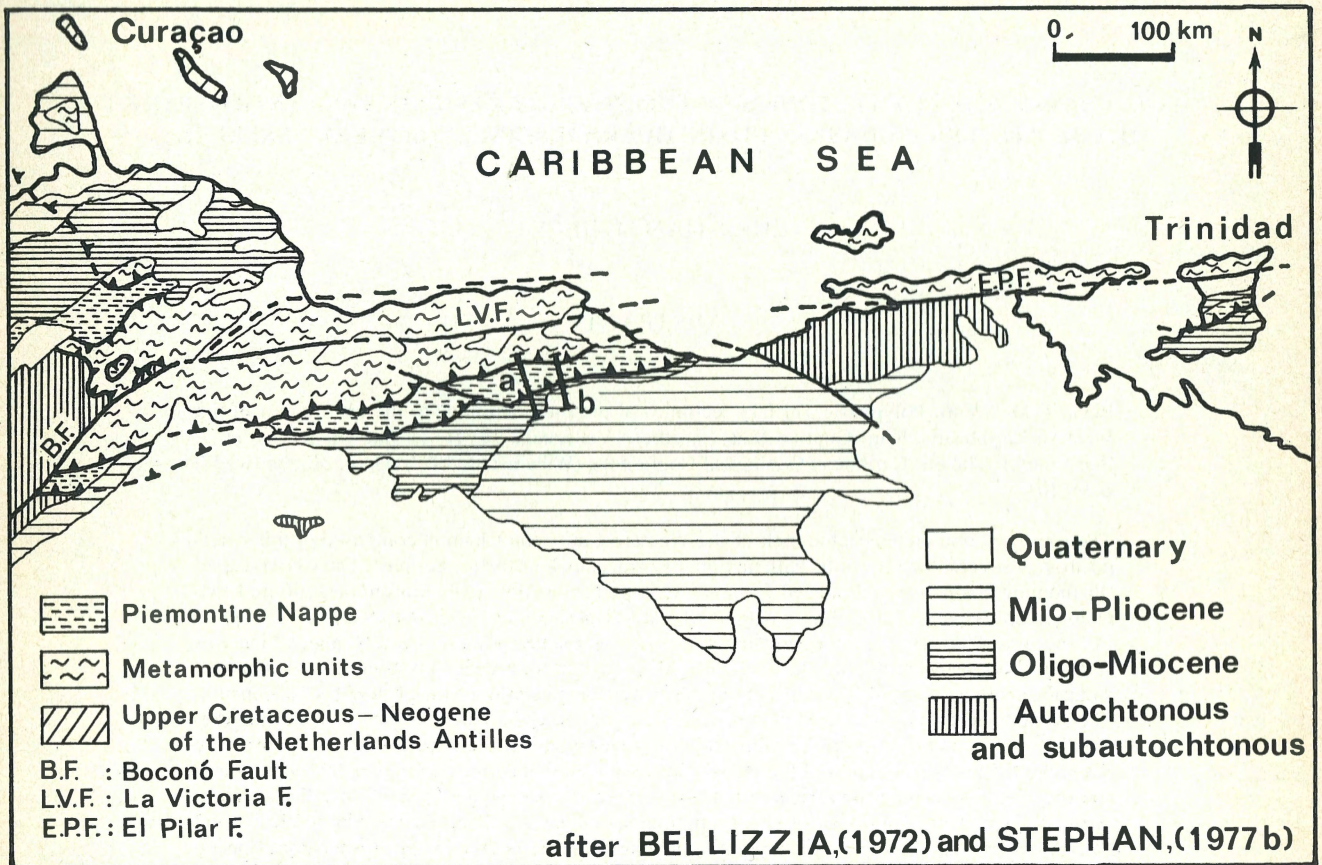


Fig. 1
Geological setting.

whose most complete sheets show the following comprehensive series:

- limy-siliceous Upper Cretaceous;
- variable uppermost Cretaceous, corresponding and the transition with the flysch;
- Palaeocene-Lower Eocene with flysch facies. The Upper Cretaceous corresponds to the Guayuta Group and the Palaeocene to the Guárico Formation (LEXICO ESTRATIGRAFICO DE VENEZUELA, 1970). Tectonic observations and lateral correlations allow a subdivision into three units.

The Guatópo Unit - The Upper Cretaceous part of this unit has few outcrops and precise dating was not possible. The transition to the flysch is sharp and the latter is essentially made up of coarse sandstones and greywackes, and

conglomerates often badly stratified. This is a 'wildflysch' following the concept of Vassoevic (in DZULYNSKI & WALTON, 1965) whose deposition can be interpreted as 'fluxoturbidites' (Unrug in DZULYNSKI & WALTON, 1965).

The Rio Orituco Unit - The Upper Cretaceous of this second unit is well developed (between 200 and 300 meters thick) and thin-bedded. Made of siliceous limestone with planktonic microfauna at its base, it includes siltstones in its middle part and shales at its top. The upper half was dated as Campanian-Maastrichtian in age². The transition to the flysch is marked by a progressive insertion of greywacke sandstones or by a very shaly sequence. The thick flysch (about 1500 meters or more) is very regularly stratified with greywacke and shaly sequences. One layer has shown a rolled benthonic microfauna of Palaeocene-Lower Eocene³.

On the south border of this unit an outcrop -detached and very small- of discordant conglomerate has shown a rich fauna of sublittoral molluscs ('*Hannatoma* fauna') dated back to the upper Middle Eocene-Upper Eocene⁴.

²Determination by P. J. Bermudez.

³Determination by J. Butterlin.

⁴Studied by O. Macsotay.

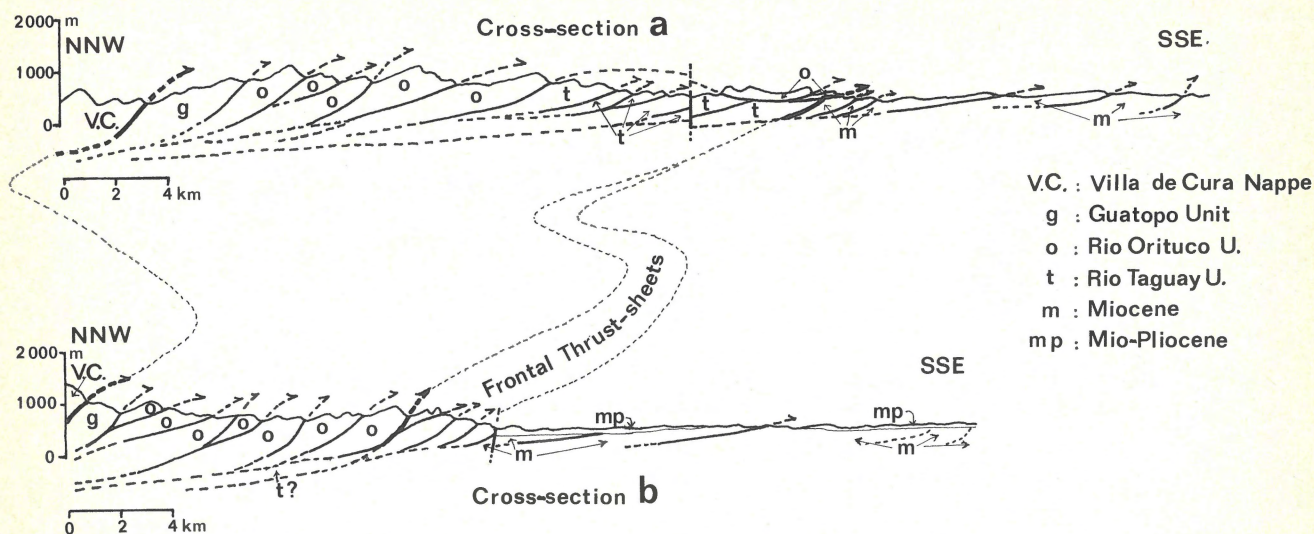


Fig. 2
Cross-sections a and b; for location see figure 1.

The Rio Taguay Unit - The third unit is particularly interesting because of showing the top of the Lower Cretaceous, in normal contact with the Upper Cretaceous. It outcrops in fenster or semi-fenster under the Rio Orituco Unit. The series begins with 20 meters of massive recrystallized limestone which includes a lot of coarse clastic quartz and rolled rudists (see STEPHAN ET AL., 1977). It ends with a limy heterogeneous conglomerate which reworks large blocks of the preceding limestone and of non recrystallized biomicritic limestone with entire rudists *in situ*. The rolled ones are thought to belong to the lower-middle Albian and the entire ones to the upper Aptian-lower Albian⁴.

This is conformably overlain by 160 to 200 meters of thin-bedded siltstones, cherts and limestones with a planktonic microfauna. The upper half, very rich in bioturbations, precedes the flysch and covers the upper Campanian and the complete Maastrichtian⁵. The Palaeocene flysch is almost only shaly (with a thickness of more than 500 meters).

The existence of a hiatus appears very likely between the top of the Lower Cretaceous and a level within the Senonian; this hiatus has been related to an early tectonic event affecting the northern edge of the Piemontine dominion (BECK, 1977 c).

Remark - West of the studied area, along the southern contact of the Villa de Cura Nappe, shales outcrop with very ill-sorted conglomerates and many large olistolites: the Los Cajones Member of the Guárico Formation (BELL, 1968). It

is not considered here as a wildflysch (lateral equivalent of the Guatopo Unit flysch) but as a peculiar formation produced during the tangential tectonisation at the end of the flysch deposition or after it, following the interpretation proposed by STEPHAN (1977 a) in the western part of the chain.

Conclusions - The present superposition of the three described units proves the great shortening suffered by the Palaeocene trough. The latter corresponds to the 'Internal Piemontine Zone' (BECK, 1977 a).

A clear polarity appears in the Palaeocene sedimentation with a 'proximal' flysch (Guatopo Unit) a 'median' flysch (Rio Orituco Unit) and a 'distal' flysch (Rio Taguay Unit).

At least the southern part of the Piemontine Nappe was detached from an Albian or pre-Albian substratum.

A tectonic phase took place between the Palaeocene-Lower Eocene and the upper Middle Eocene-Upper Eocene.

The frontal thrust-sheets zone

This zone outcrops without continuity in the eastern part of the area studied (cross-section b on figure 2); it shows three superposed components (from north to south) (see figure 3):

(1) Very small thrust-sheets whose varied material allows the reconstitution of a hypothetical 'External Piemontine Series' where a quite complete Cretaceous is represented: gypsum at the base, massive limestones with stromatoporoids, calpionellas and foraminifera of Berriasian-Valangian age (BECK & FURRER, 1977), sandstones of presumed Barremian age (locally in normal contact with the

⁴Studied by O. Macsotay.

⁵Determination by G. Bizoz, C. Muller and J. Sigal.

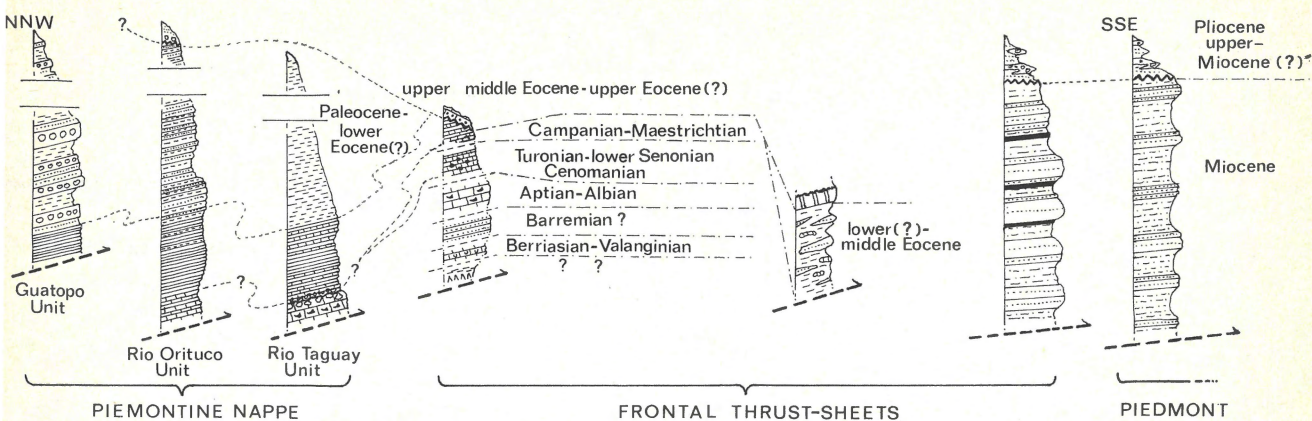


Fig. 3
Stratigraphic columns of the various units.

following limestones), massive limestones with nerineids and rudists of Aptian-Albian age⁶, thin-bedded limestones with ammonites of Turonian-Coniacian age⁶, siliceous thin-bedded limestones with planktonic microfauna of Campanian-Maastrichtian age². The whole set presents clear similarities with the sub-autochthonous Cretaceous of the Eastern Caribbean Chain (HEDBERG, 1950) and also with the Rio Taguay Cretaceous.

Several of these thrust-sheets show reduced outcrops of discordant limy glauconitic conglomerate or breccia with macroforaminifera of upper Middle Eocene-Upper Eocene age⁶.

(2) Muddy shales with slumped lenses of quartzitic sandstones and small olistolites made of material from the preceding series. This formation, very deformed, ends normally with glauconitic limy sandstones and, above, one layer of limestones with algae and macroforaminifera of upper Middle Eocene-Upper Eocene age². The top of this limestone (Peñas Blancas Formation) shows a lack of sedimentation and, maybe, a regression.

(3) One thick series of muddy-shaly sands intercalated with thick sandstones and several coal beds (Naricual Formation) which is considered to be of lower Miocene age by VIVAS & CAMPOS (1977).

Remark - BELL (1973) considers that all three components of this zone belong to one 'stratigraphically condensed Early Cretaceous-Oligocene marine sedimentary sequence'.

Conclusions - The Cretaceous rocks of this zone suffered one tectonic event after the uppermost Cretaceous and before the

upper Middle Eocene (like the Piemontine Nappe).

Both these rocks and the Neogene series suffered a second tectonic phase after the Lower Miocene.

The Piedmont

The Piedmont consists of a thick molassic-type formation with large sandy, shaly and muddy sequences (each about 50 meters thick) intercalated with thick, well-stratified layers of sandstones (Quebradon or Chaguaramas Formation). As it contains, at different levels, a few pelecypods of paralic shallow facies⁶, and as the total thickness is thought to be more than 4000 meters (LEXICO ESTRATIGRAFICO DE VENEZUELA, 1970), it is necessary to admit a subsidence. One pelecypod is of probable Upper Miocene age⁶.

These rocks outcrop as large monoclinical sets lightly dipping North separated by quite horizontal fault-planes within a 20 km wide strip along the southern boundary of the Piemontine Nappe. More to the south, this tectonism gets lighter and disappears.

Near the Thrust-sheets Zone or farther to the south, this Miocene is covered with a muddy-sandy formation with non-consolidated conglomerate lenses (Peña Mota Formation) which is supposed to be of uppermost Miocene or Pliocene age without palaeontological argument.

TERTIARY TECTONIC HISTORY OF THE PIEMONTE NAPPE; CONCLUSIONS

The stratigraphic data summed up in the foregoing chapter show the existence of two tectonic events affecting the Piemontine Zone and its southern edge. Mesoscopic tectonic studies also show the superposition of two main deformations: the first mainly producing sub-isoclinal folding, axial-plane fracture-cleavage and thrust-faults, the second producing mainly lightly dipping thrust-faults (with in-

²Determination by P. J. Bermudez.

⁶Determination by O. Macsotay.

v.c. : Villa de Cura Nappe
 f.t.s. : Frontal Thrust-sheets
 p.n. : Piemontine Nappe
 p. : Piedmont
 s.l. : sea level

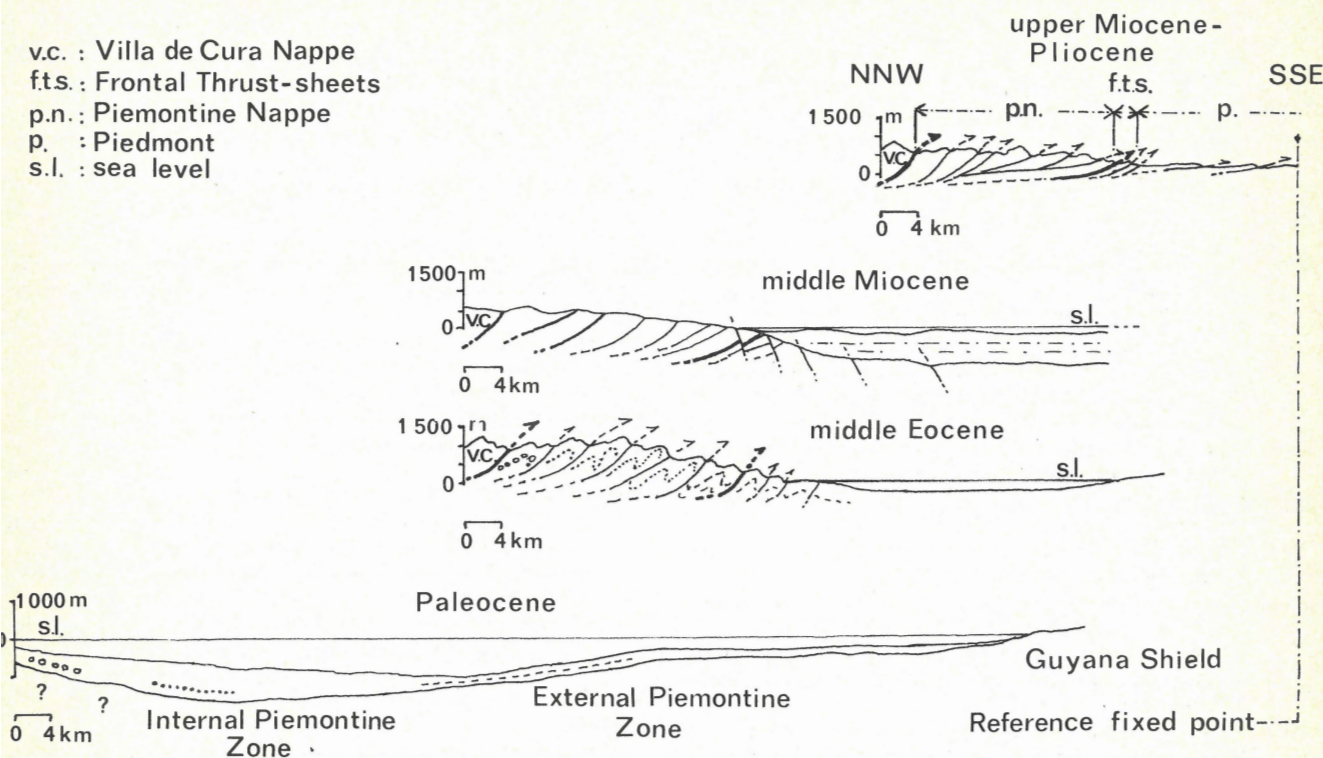


Fig. 4
 Various cross-sections.

harmonic folding below) and a second movement along the precedent fault-planes. These deformations have a very great homogeneity in their axial direction (N 65° to 75° E). When it occurs, the cleavage clearly postdates the diagenesis (refracted while entering a sandstone bed or crossing flattened bioturbations). Many NNW-SSE vertical faults with frequent dextral transcurrent displacement affect the Piemontine Nappe in relation to differential movements within the latter.

An opened fracturing, of small scale, affects the Piemontine Nappe, due to an approximate NNW-SSE distension. This can be related to the subsidence during the Miocene.

We thus conclude that the Piemontine Zone, in the area studied, suffered the following tectonic events:

- (1) A major NNW-SSE compression during the upper Lower Eocene (?) - lower Middle Eocene; the Piemontine Zone was strongly shortened and overthrust by the Villa de Cura Nappe. This phase corresponds to the overthrusting of the Lara Nappe in the western part of the chain (STEPHAN, 1977 b).
- (2) An approximately NNW-SSE distension during the Oligocene (?) - Miocene which produced a subsiding furrow along the southern edge of the palaeorelief formed before.
- (3) A second NNW-SSE compression -less important than the first- which produced a new shortening of the Piemontine

Nappe, its partial overthrusting on the Piedmont Miocene, and a superficial shortening of the latter. This second compressive phase occurred probably during the Middle-Upper Miocene.

(4) A Pliocene or more recent light faulting occurred along the southern edge of the Piemontine (but we have very little information about this neotectonism in the area studied).

The total shortening -which affected only the Cretaceous-Tertiary sediments independently of their substratum- is estimated at a hundred kilometers or more (see figure 4).

This tectonic chronology is partially in accordance with PEIRSON's conclusions (1965) further east, and those of HEDBERG (1950) in the Eastern Caribbean Chain. On the contrary the author's conclusions are different from those of BELL (1968, 1971, 1973), GONZALEZ SILVA & PICARD (1972) and BELLIZZIA (1972) who suggest a continuous tectonic event between Upper Eocene to Miocene-Pliocene time.

On the other hand, the mesoscopic tectonic observations, the great homogeneity of the deformations in the whole area studied, the dipping of all the thrust-fault planes (there is no argument to say that they were dipping south during the Palaeogene and the Neogene) and the polyphasic process are in opposition to the hypothesis of a gravity sliding of the Piemontine Nappe.

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