Tectonophysics, 66 (1980) 349—372

THE DISRUPTED OPHIOLITIC BELT OF THE SOUTHWEST PACIFIC: EVIDENCE OF AN EOCENE SUBDUCTION ZONE

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(Received January 4, 1979; revised version accepted May 28, 1979)

ABSTRACT

Parrot, J.F. and Dugas, F., 1980. The disrupted ophiolitic belt of the southwest Pacific: evidence of an Eocene subduction zone. Tectonophysics, 66: 349—372.

The Papua-New Guinea, Solomon, New Hebrides and New Caledonia ophiolitic massifs come from an Eocene intra-oceanic subduction occurring in the southwest Pacific. This hypothesis is suggested by the age of the ophiolite-related metamorphic soles which would be the result of a metamorphism arising at the expense of volcanic and sedimentary series of oceanic supracrustal origin when involved in a subduction zone. When this subduction also involves a continental crust portion, amphibolites and blue schists are formed, as observed in Papua-New Guinea and New Caledonia. When the subduction occurs in an intra-oceanic environment, as in the Solomon islands and New Hebrides, only amphibolites and green schists are to be found.

The ophiolitic belt (basic-ultrabasic massifs and their related metamorphic soles) created by the Eocene subduction has been disrupted by later transcurrent faults, more recent spreading phenomena and two other subductions (Oligocene—Miocene and Recent).

INTRODUCTION

In the southwest Pacific, several basic-ultrabasic massifs have been studied or observed, notably in Papua-New Guinea, Solomon Islands, New Hebrides and New Caledonia (Fig. 1). One generally assumes an origin, either from an active marginal basin situated to the rear of a volcanic arc, or from an intra-oceanic subduction plane inducing a further thrusting. The similar age of the metamorphic formations related to those ophiolitic assemblages led us to consider whether they have been formed from an unique subductive event. In this case, Papua-New Guinea and New Caledonia are not directly linked, but are in fact connected by means of the Solomon Islands and the New Hebrides. Thus, the generating subduction zone would have been subsequently disrupted by a transform fault system and two later subductions, the first one active during the Oligocene—Miocene, the second one during the Pliocene and the Present.

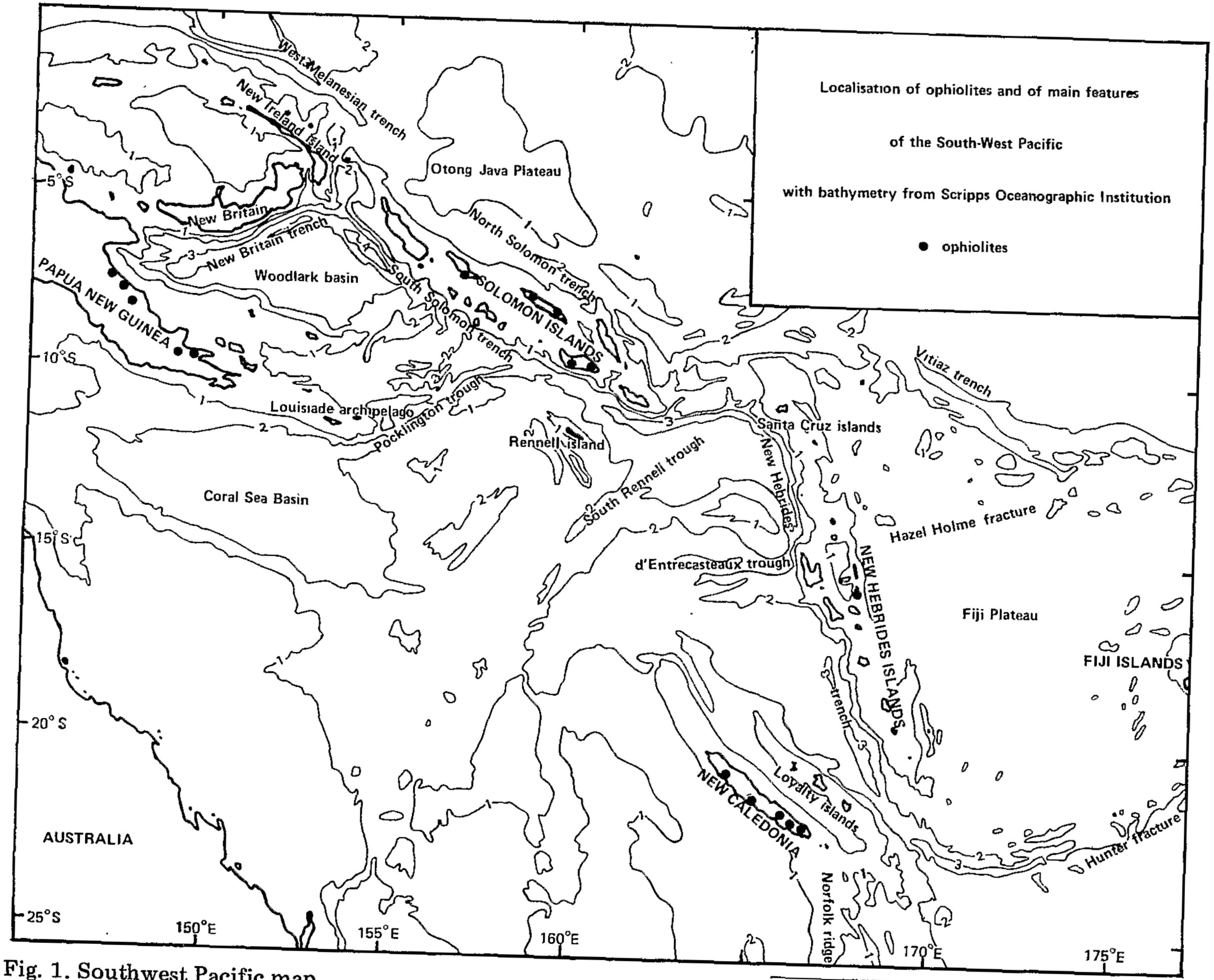

Fig. 1. Southwest Pacific map.

REGIONAL DATA

Papua-New Guinea

The basic-ultrabasic units of Papua-New Guinea are composed of tectonic harzburgites, peridotitic and gabbroic cumulates, and tholeiitic pillow-lavas (Davies, 1971; England and Davies, 1973; Milsom, 1973; Brookfield, 1977). The tectonic contact of these units on to a Cretaceous substratum is marked by amphibolitic and pyronexenetic granulite lenses linked to deep green schists and locally to blue schists with glaucophane and lawsonite. The first levels of the sedimentary transgression on to the basic-ultrabasic massifs are of Lower Miocene, and may be of Upper Oligocene age. On the other hand, a date of 55 m.y. to 50 m.y. for tonalites cutting the basic formation, and another one of 52 m.y. for a hornblende granulite of the thrusting zone were obtained (Davies, 1971; Davies and Smith, 1971). Thus, these data would indicate that the emplacement of the ophiolitic massifs took place after the Lower Eocene and before the Upper Oligocene. For Davies and Smith (1971) who gave these data, this period would correspond to a subduction of the oceanic crust under the Pacific plate, and this subduction has to be related to the metamorphism of a part of the supra-crustal sediments. The emplacement of ophiolites would result in an uplift of the whole region during the Oligocene. The volcanic arc associated with the Eocene subduction would correspond to the coastal range of Papua-New Guinea (Johnson et al., 1978b). This event is followed by an Upper Oligocene and Lower Miocene volcanism (Bain et al., 1975), linked to strike-slip faults consecutive to the arrival of the Australian border in the collision zone, and an actual one developed northeastwards.

Solomon islands

Coleman (1966) has defined three provinces; they present a NW—SE direction. This distinction is provided by the nature of the formations and the tectonic patterns.

In the northern part, the "Pacific province" is essentially composed of Tertiary pelagic oozes resting on a basaltic floor. Only the "Central province" contains basic-ultrabasic massifs, especially in Choiseul, Santa Isabel, Florida, Guadalcanal and San Cristobal islands (Coleman and Hackman, 1974). These massifs are formed by harzburgites (Stanton and Ramsay, 1975) and serpentinites associated with lavas, gabbros and metamorphic rocks ranging from the deep green schists to epidote albite amphibolite facies. A Paleocene age is proposed for the metamorphic formations (Richards et al., 1966). As in Papua-New Guinea, a Lower Miocene transgression was observed (Coleman, 1966; Coleman and Hackman, 1974).

An extensive fault delineated by a serpentine belt, the Korighole belt, bounds the "Central province" on its northern border, on the northeastern dipping, root-zone of the basic-ultrabasic associations. This fault would be evidence for the subduction which has induced the subsequent ophiolitic thrusting on to a more meridional portion of the oceanic crust.

The volcanism of the "Pacific province" observed in Santa Isabel and Malaita Island and described by Hughes and Turner (1977) as younger basalts overlying an oceanic tholeiitic basement, would be the remnant arc linked to this subduction.

The third province, the "Volcanic province", is formed by Upper Pliocene to Present volcanic formations (Grover et al., 1971; Coleman and Hackman, 1974), corresponding to the volcanism of the actual southern subduction (South Solomon trench) (Denham, 1969, 1973).

Moreover, the intensive fracturing and the Oligocene or Middle Miocene associated intrusions observed in the "slot" of the "Central province" (De Broin et al., 1977), and also in the New Ireland island (Johnson et al., 1978a), would be the result of another subduction presenting a southerly dip of which the West Melanesia, North Solomon and Vitiaz trenches would be the trace (Halunen and Von Herzen, 1973; De Broin et al., 1977).

New Hebrides

Rafts of amphibolites and green schists in serpentines associated with peridotites (harzburgites and saxonites) and gabbros, outcrop in Pentecost Island (Mallick and Neef, 1974). Though no ophiolites have been recognized in Maewo, the large positive gravity anomalies emphasized by Malahof (1970) on Maewo and Pentecost islands, the largest one occuring on Maewo, suggests that these islands, both alike, present a peridotitic basement.

If we can assume, as for the two preceding areas, a link between metamorphism and subduction, two radiogenic ages (Mallick and Neef, 1974) seem to indicate that the subduction was active at least between 35 m.y. and 28 m.y. ago; but these ages are at odds with Gorton's (1974) 5.7 and 13.6 m.y. ages determinations. The same conflict appears again if we attempt to take into account the different radiogenic ages obtained northwards in Santa Cruz and Torres islands. The 26 m.y. age (Hughes et al., 1978) from the basal volcanic formation of Nendo (Santa Cruz islands) would be evidence for a volcanic arc related to an old subduction, as would the volcanic formation of Torres islands, the radiogenic ages of which, given by Greenbaum et al., (1975) are 39 and 36.7 m.y. Unfortunately, as stated by the authors themselves, there is, in the Torres islands, a conflict between the radiogenic ages from Hiu and the 20 to 25 m.y. foraminiferal ages from the nearby island of Toga.

Later volcanic and sedimentary series can be found in Pentecost and neighbouring islands: for example, in Santo and Malekula where the greatest ages are Upper Oligocene (Mitchell and Warden, 1971) and in Maewo where the Lower Miocene contains pebbles of Upper Eocene limestone (P.J. Coleman, 1969).

Meanwhile, in contrast to the preceding areas, the contact between basic and ultrabasic slices and their likely cover of Miocene age occurs through vertical faults; thus, it is difficult to display the transgression. The faults are the result of a recent uplift which caused (Mallick and Neef, 1974) the emplacement of the ophiolites and their metamorphic sole about 4 m.y. ago. This event has to be related to a recent and still occurring subduction westward of the trace of the Eocene subduction plane.

This last subduction is emphasized by an important seismicity (Dubois, 1969; Dubois et al., 1973; Pascal, 1974; Louat, 1977; Pascal et al., 1978) and since 5 m.y. by an active volcanism (Mitchell and Warden, 1971; Mallick, 1973; Colley and Warden, 1974; Gorton, 1974; Carney and MacFarlane, 1977, 1978; Dugas et al., 1977a, b; Ravenne et al., 1977); this subduction would be related to the recent Fiji plateau spreading (Falvey, 1975; Hawkins and Batiza, 1975).

New Caledonia

The ophiolitic assemblage overlies most of the island. It is formed by tectonic harzburgites, peridotitic and gabbroic cumulates (Avias, 1953, 1977; Routhier, 1953; Guillon and Routhier, 1971; Guillon, 1974, 1975; Rodgers, 1975, 1976). This assemblage rests on a continental substratum, the upper levels of which are Senonian, by means of a volcanic and sedimentary series partly metmorphosed in green schists and epidote amphibolites (Avias, 1953, 1977; Routhier, 1953; Lillie, 1970; Lillie and Brothers, 1970; Brothers, 1974; Guerange et al., 1975). Dates given by three basaltic samples of those series gave an age of 38.5 m.y. (Guillon and Gonord, 1972). Moreover, in the northern part of New Caledonia, one can find ophiolitic melanges metamorphosed in the blue schist facies (Black and Brothers, 1977). The authors obtained an age of 41 m.y. from these and showed that this metamorphism is completely different from the epizonal one, also of blue schist facies type, but formed at the expense of the substratum. This last metamorphism extends from 38 to 21 m.y. ago (R.G. Coleman, 1967—1971). Two interesting dates (32 and 25 m.y.) were given for plagiogranites going up across the peridotites (Guillon and Gonord, 1972; Guillon, 1975).

The ophiolitic assemblage plunges eastwards (Crenn, 1953; Collot and Missegue, 1977) as well as an eastern ensemble of deep faults from Loyalty basin (Dubois et al., 1974) interpreted as the trace of an old subduction zone (R.G. Coleman, 1971; Avias, 1971, 1973; Lapouille and Dugas, 1975; Aubouin et al., 1977; Lapouille, 1977a, b; Paris and Lillie, 1977) that would have been active from Eocene to Early Oligocene time (Brothers, 1974; Blake et al., 1977). This subduction trace has been also described along the east side of the Norfolk ridge and can be followed to New Zealand (Lapouille, 1977a).

In a scheme of this type, the Loyalty Islands would correspond more or less to the volcanic arc linked to this event. Unfortunately, the date of

28 m.y. found by Chevalier (1968) is inconsistent with another one of 11 to 9.3 m.y. given by Baubron et al., (1976). As for the preceding case, the emplacement of ophiolitic nappes is succeeded by a Miocene transgression (Routhier, 1953; Latham, 1974, 1977; Coudray, 1975, 1977) and the subsequent tectonic history is simply the result of a recent faulting (Orloff and Gonord, 1968; Coudray, 1969; Trescases, 1969; Gonord and Trescases, 1970; Gonord et al., 1973; Guillon, 1974).

Oceanic zone

The oceanic area surrounding the four regions previously described, provides much information about the geological evolution of the southwest Pacific.

Woodlark basin and Pocklington trough. Northeastwards of Papua-New Guinea, the Woodlark basin presents two spreading stages consistent with simultaneous tectonics of Eastern Papua: the first one round about 20 m.y. ago, the second one during the last 3 m.y. (Luyendyk et al., 1973). These authors have considered the Pocklington trough, perpendicular to the Woodlark basin, as a fracture zone rather than a trench (Karig, 1972). Although Recy et al. (1977) support the idea that the Pocklington trough is a subduction trench, they do not present convincing morphological arguments against the interpretation of Luyendyk et al. (1973) who indeed suggest, as does Carey (1958), that this trough marks the trace of the rotation of New Guinea away from Australia. In fact, the Pocklington rise, which is seismically inactive and shows low magnetic anomalies, is probably made of, according to Louisiade archipelage uplifted outcrops, a Cretaceous—Eocene metamorphic complex which continues west into Papua (Davies and Smith, 1971) and was affected by block faulting.

West Melanesia, North Solomon and Vitiaz trenches. The West Melanesia and North Solomon trench studied by De Broin et al. (1977) and the Vitiaz trench which extends it eastwards (Chase, 1971; Jezek et al., 1977; Recy et al., 1977) correspond to the trace of a fossil subduction zone (Karig, 1972; R.G. Coleman, 1977). The descending slab was dipping southwards (Halunen and Von Herzen, 1973) during the Oligocene (Wiebenga, 1973; De Broin et al., 1977; Johnson, 1978a, b) and stopped 12 m.y. ago because of the arrival of the Otong Java Plateau in the trench zone. Jezek et al. (1977) believe that this last event gave rise to an evolution of the subduction into a fracture zone. Remains of the volcanic arc linked to this subduction can be observed in New Ireland (Johnson et al., 1978a, b) and would correspond to intrusions in the northern edge of the Solomon central province "slot" (De Broin et al., 1977).

South Rennell trough. The NE—SW South Rennell trough, situated between the Solomon Islands and New Caledonia, is interpreted by Larue et al.

(1975, 1977) as a spreading zone. The distribution of magnetic anomalies involves an opening rate more important in the northeast than in the southwest. The probable Oligocene age of the rifting (Larue et al., 1977) is partly confirmed by further coral building of Rennell island during the middle Miocene (Bourrouilh et al., 1976). On the other hand, Recy et al. (1977) have suggested the presence in this area of a fossil subduction having a northeast dip. This "Rennell subduction" is perpendicular to the Oligocene spreading zone previously described and the various ages proposed for it by the authors do not allow to know if it was active before or during the spreading. In the first case it would be the evidence of the Eocene subduction; for the second one it could be, in fact, a fracture zone related to the expansion.

d'Entrecasteaux trough. The E—W d'entrecasteaux fracture zone (Chase, 1971), situated eastward near Santo island, is interpreted by Daniel et al. (1977) as a transform fault more or less connected, by means of a transition zone, with an Eocene Loyalty subduction like the southern scheme generally advanced to explain relations between the actual New Hebrides subduction and the Hunter fracture zone (Chase, 1971). In fact, the transition between the d'Entrecasteaux fracture zone and the area which extends offshore in the north of New Caledonia is not so clear, and morover, the ENE—WSW magnetic lineations of this last region stop abruptly there (Weissel et al., 1977). So, for us, the d'Entrecasteaux fracture zone is considered to be a lengthening of the Hazel Holme fracture described by Chase (1971). In this case, the d'Entrecasteaux—Hazel Holme fracture zone would be the evidence for intensive fracturing of the oceanic crust, as are the regional fractures observed to the south by Dubois et al. (1974) and Daniel et al. (1977).

The Norfolk ridge. The N—S Norfolk ridge links New Caledonia and New Zealand (Dubois et al., 1974; Dupont et al., 1975; Lapouille, 1977b; Ravenne et al., 1977). The virgation of the ridge observed southwards from New Caledonia is thought to be subsequent to an anticlockwise rotary motion related to the Miocene ophiolite emplacement on to the New Caledonia platform. Basaltic pebbles of Lower Miocene age have been dredged in this joint area (Daniel et al., 1976).

TENTATIVE RECONSTRUCTION OF SW PACIFIC TERTIARY AND ACTUAL MOTIONS

Ophiolitic assemblages of various ages have a metamorphic sole everywhere. Among others, Dewey and Bird (1971) think that volcanic and sedimentary oceanic formations are metamorphosed into the blue schists facies when they are involved in a subduction zone. Recently, Parrot and Whitechurch (1978) have suggested a similar hypothesis for both facies types of ophiolite-related metamorphic soles: green schists and blue schists. They demonstrated that for each level of mesogean ophiolite-related metamorphic

TABLE I

K-Ar radiometric ages determinations (in m.y.)

	Papua-New Guinea	Solomon
Oceanic crust	150 (WR, Γ) (1) 147 (WR, Γ) (1) ≤116 (WR, lava) (2)	
Metamorphism and reequilibrated rocks	55 to 50 (WR, tonalite) (1) 52 (WR, hornblende granulite) (1)	51.5 to 49.5 ± 6.8 43.6 to 40.6 ± 6.8 44.3 to 32.4 ± 6.8 (hornblendes, plagioclases from amphibolites, Choiseul) (4) 44.7 ± 2.1 (hornblende from tremolite-talc) (4) 35.2 ± 1.4 (hornblende from amphibolite, Small Nggela) (5) (6) 38.4 ± 0.7 (hornblende from gabbro, Small Nggela) (5) 36.7 ± 0.4 (plagioclase from gabbro, Small Nggela) (5)
V_1		
Thrusting instrusions (ante or during)	presence of plagiogranite (5)	
Ophiolite emplacement	ante lower Miocene (2)	ante Lower Miocene (7)
V_2 or contemporaneous volcanism in the New Hebrides area	13.0 ± 0.2 to 14.1 ± 0.3 (3) (WR, olivine β) 14.6 ± 0.3 to 15.0 ± 0.3 (3) (WR, pyroxene α) (WR, hornblende α) 14.5 ± 0.2 and 13.9 ± 0.2 (3) (WR, pyroxene α; WR, α)	
V_3		

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(1) Davies and Smith, 1971

(2) Davies, 1971

New Hebrides and Santa-Cruz	New Caledonia	Oceanic zone
		52 to 45 (North Loyalty basin) (24)
35 ± 2 [a] (hornblende from amphibolite, Pentecost) (8)	53.6 ± 0.4 and 44.7 ± 0.4 (hornblendes from amphibolite) (18) 41.7 ± 2.6 and 41.1 ± 2.5 (phengites from paraschist) (18) 39.3 ± 0.7 and 37.6 ± 1.1 (WR, metagraywacke; paragonite from gneiss) (19) 36.7 ± 1.4 and 36.2 ± 1.1 (phengite; phengite and paragonite from gneiss) (19) 36.8 ± 1.1 (phengite from metagraywacke) (20) 38-21 (?)	
39 ± 5 to 36.7 ± 1 [b] (WR, α, Torres) (9) 26 (WR, lava, Santa Cruz) (10)	38.5 ± 1.5 (WR, β) (21)	
28 ± 6 [c] (WR, Γ Pentecost) (8) 25 ± 2 (WR, δ, Santo) (9,12) presence of plagiogranite, Pentecost (8)	32 ± 3 (WR, plagiogranite) (21) 25 (WR, grano-δ) (22)	
about 4 m.y. (8)	ante Lower Miocene (23)	
16.0 ± 0.5 to 14 ± 0.6 (WR, dyke, Malekula) (12) 20.3 ± 0.4 to 16.8 ± 0.3 (WR, hornblende and plagioclase from Γ Malekula) (11) 13.6 ± 0.8 [c] (WR, Γ Pentecost) (11) 12 ± 5 (WR, dolerite, Pentecost) (11)		12.5 ± 4.2 [b] (WR, αβ, Mitre) (25)
7.3 ± 0.2 (WR, β, Maewo) (11) 6.4 to 3.2 (WR, α and β, Pentecost) (11) 5.7—5.5—2.4 (WR, βα WR-WR, Erromango) (12,13,14) 3.5—1.8—0.8 (WR, β, Banks) (14,15) 2.4 to 0.09 (WR, β, Tanna) (16) 1.8 ± 0.05 (WR, α, Foutouna) (16) 1.5—1.3 (WR, Efate) (14,17) 0.7—0.1 (WR, βα, Epi) (11) 0.1—0.06 (WR, β, Aoba) (11) 0.07 (WR, β, Tongoa) (11) 0.01 (WR, β, Ambrym) (11)		

(3) Page and McDougall, 1970
(4) Richards et al., 1966

TABLE I (continued)

(5) Neef and McDougall, 1976
(6) Neef and Plimer, 1979
(7) Coleman and Hackman, 1974
(8) Mallick and Neef, 1974
(9) Greenbaum et al., 1975
(10) Hugues et al., 1978
(11) Gorton, 1974
(12) Snelling report in Gorton, 1974
(13) Colley and Ash, 1971
(14) Amdel, (New Hebrides Geol. Survey oral communication),
(15) Mallick and Ash, 1975
(16) Centre des faibles radioactivités, Paris-Gif in Dugas et al., 1977 b
(17) Laboratoire de Géochronologie Paris-Orsay, France
(18) Black and Brothers, 1977
(19) Blake et al., 1977
(20) Coleman R.G., 1967
(21) Guillon and Gonord, 1972
(22) Guillon, 1975
(23) Routhier, 1953; Latham, 1974, 1977; Coudray, 1975, 1977
(24) Weissel et al., 1977; Lapouille, 1978
(25) Jezek et al., 1977
WR = whole rock
a = questionable by other authors
b = questionable by the authors themselves
c = the two ages concerning the Pentecost gabbro are in conflict

α = andesite
β = basalt
Γ = gabbro
δ = diorite
αβ = andesite basalt
βα = basalt andesite

soles, there is a corresponding non-metamorphic level of oceanic-type volcanic and sedimentary series thrust with ophiolitic nappes. The same phenomenon has been recently suggested in the Pacific area (Hawkins and Batiza, 1977). Parrot and Whitechurch (1978) assume that, depending on the subduction rate, a similar material could produce either type: green schists and amphibolites for a low speed, blue schists for a high one. The eventual proximity of a continental crust would also be an important factor for the formation of blue schists.

Now, as presented in the chapter concerning regional data, a similar age event marks all southwest Pacific ophiolite-related metamorphic soles. Figure 2 illustrates a tentative integration of the radiometric data reported in Table I, in an unique subductive event that would have taken place between at least 41 m.y. and 26 m.y. ago. A consecutive ophiolitic nappe thrusting would have followed this event on to the New Guinea and New Caledonia continental crust portions, the corresponding trench remaining in an oceanic

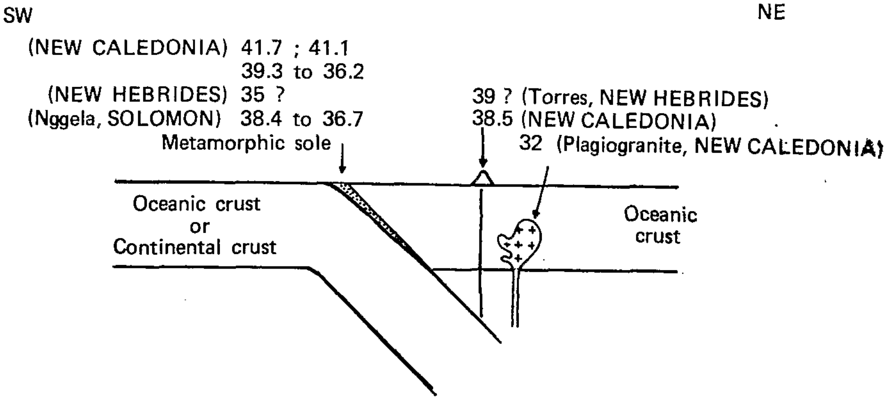

Fig. 2. Position of comparable age samples in the same geotectonic system (subduction S_1).

environment, in the Solomon and New Hebrides islands, until the time when it will be uplifted by further motions.

We have to point out that intra-oceanic flaking-off in the mesogean area, is emphasized by the presence of scattered swarms of diabasic dykes and sometimes plagiogranitic veins and dykes cutting the lower level of the ophiolitic assemblages (Parrot, 1977; Çakir et al., 1978; Juteau, 1979), and one can observe obviously the same relationships within the basic-ultrabasic massifs of the soutwest Pacific.

Meanwhile, in Papua-New Guinea, an age of 68 m.y. obtained from some metamorphic rocks and another one of 50 m.y. for an intrusive tonalite, would indicate the existence of an older subduction zone. Johnson et al. (1978b) assume a southward dip underneath New Guinea before the northward subduction in the Eocene. On the other hand, Milsom (1973), believes there to have been an ocean-directed subduction before the Eocene one and this was followed by the formation of piles of slices, favouring further thrusting by gravity on to Papua-New Guinea.

The Eocene subduction (S_1) (Fig. 3)

The southward and south-westward ophiolitic thrusting implies that the corresponding Eocene subduction (here called S_1) was plunging north-eastwards (Johnson et al., 1978a, Rodgers, 1976; Lille and Paris, 1977). This subduction is indicated by the almost similar ages of the ophiolite-related metamorphic soles, and the volcanism observed in Santa Isabel and Malaïta in the Solomon islands (Coleman and Hackman, 1974), in Nendo, one of the Santa Cruz islands (Hughes et al., 1978), and probably the one observed in Fiji (Chase, 1971) and the Loyalty islands (Lapouille, 1978), which would be the trace of the corresponding volcanic arc (Named V_1 in all the figures).

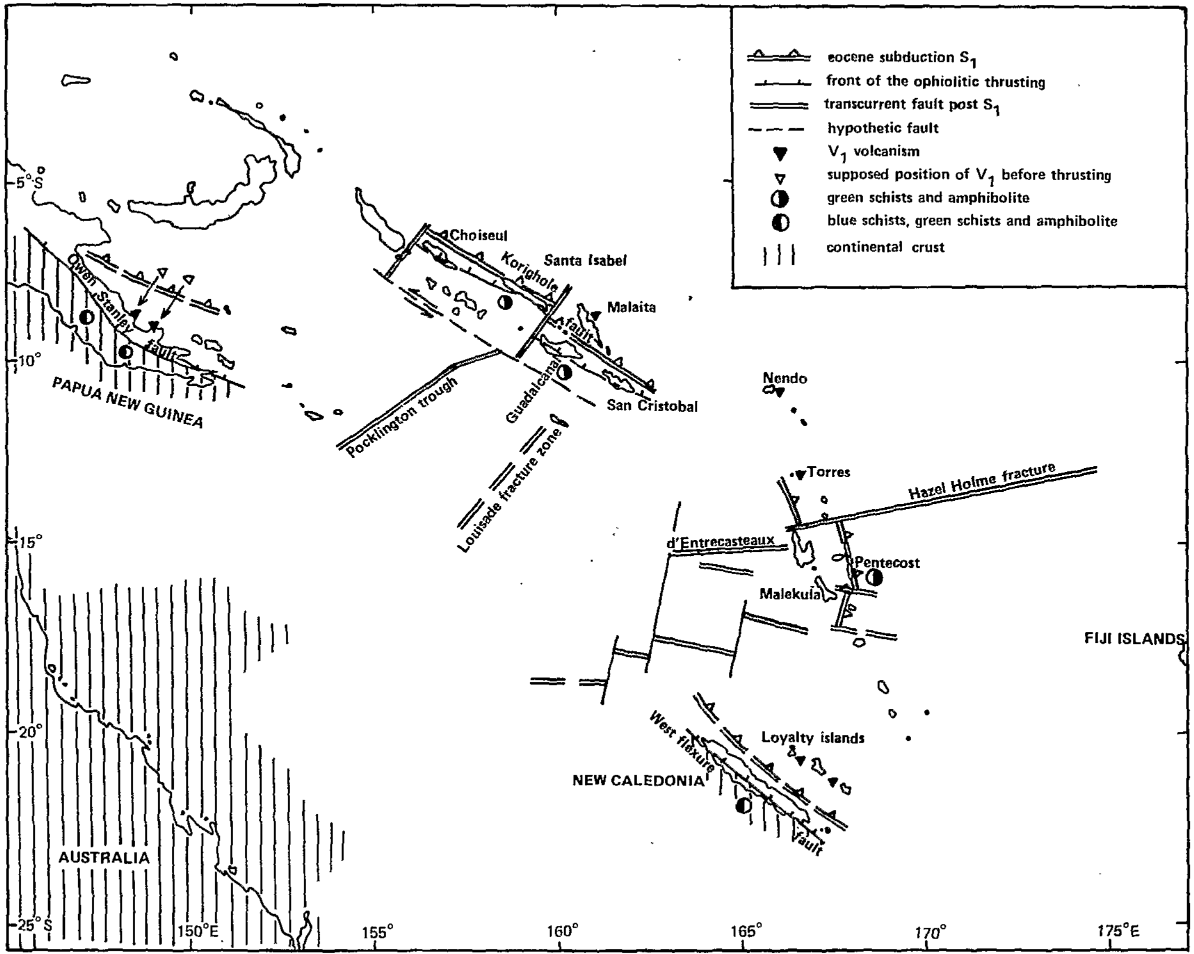

Fig. 3. Trace and fracturation of the Eocene subduction (S_1) with the ophiolitic assemblage.

However, in Fiji, Gil (1976), Carney and MacFarlane (1978) attributed the Eocene volcanism to a southward dipping subduction zone.

Thus, it seems reasonable to associate the genesis of rocks forming the metamorphic soles to this subduction and to assume that this event induces the subsequent thrusting.

The end of the subduction S_1 would correspond to the regional gap between the Upper Eocene and Middle Oligocene (Andrews et al., 1973). This event has to be related with the changing direction of plate motion (Le Pichon and Heirtzler, 1968) that was E—W before 44 m.y. and N—S between 44 and 20 m.y. (Chase, 1971).

The emplacement of ophiolitic nappes would occur later, before the Miocene. In fact, except for the New Hebrides where the emplacement is more recent (Mallick and Neef, 1974), and without any field evidence of the Pentecost ophiolite thrusting, the first erosion of peridotites happens at the beginning of the Aquitanian in New Guinea (Davies, 1971), the Solomon Islands (Coleman and Hackman, 1974) and New Caledonia (Routhier, 1953; Latham, 1974).

The post-S_1 transcurrent fault system and the South Rennell fanshape spreading zone

The subduction zone and the related thrusting zone would have been disrupted by a further sliding fault system perpendicular to them. Those faults would have involved a left transverse faulting between New Guinea and the Solomon islands and a right one between the New Hebrides and New Caledonia, as a series of sliding faults in the whole area. Remains of those fractures have been observed mainly north of New Caledonia and we assume the Hazel Holme—d'Entrecasteaux fracture zone is evidence of them. Moreover the Pocklington trough, also one of them, was translated from west to east by a perpendicular transcurrent fault. This fault trace can be observed northward of Banks Island and probably on the field of the South Solomon subduction. Furthermore, subduction could be initiated along this former transcurrent fault by a recent change in direction of the Indo-Australian plate motion.

The south Rennel sphenocasme would have produced a small opening in the Southern plate portion as defined by the east—west transcurrent fault, between the Papua-New Guinea area and the New Caledonia-New Hebrides area and its removal on both sides of the axis. Then again, the connection of this movement with the still continuing motion of the southern portion would have induced a distortion, not only of the spreading zone but also of the old transcurrent fault system, leading to the actually observed disposition northward of New Caledonia.

The Oligocene-Miocene subduction (S_2)

Correlating the development of the South Rennell sphenocasme, another subduction zone dipping south (Fig. 4) and related to a new change in the

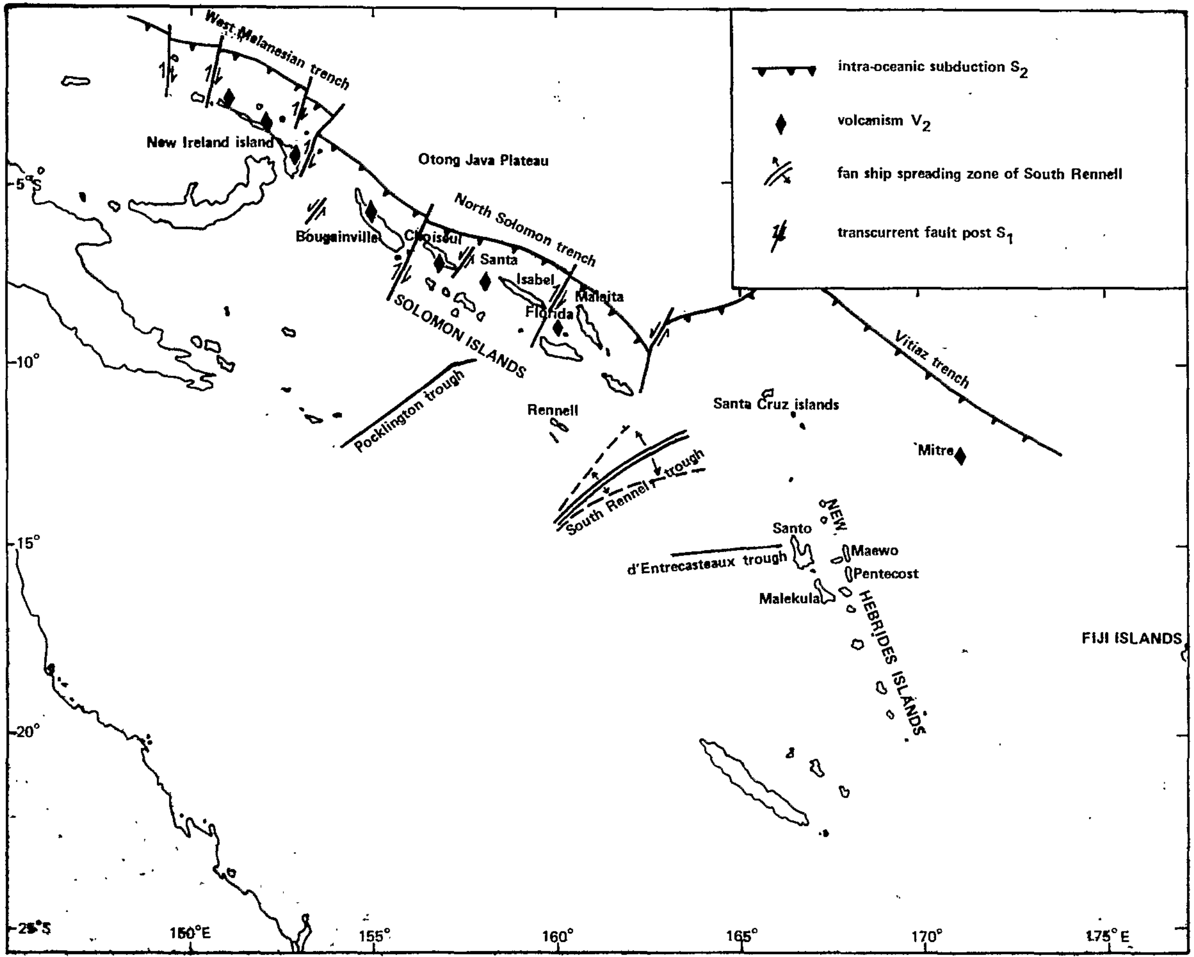

Fig. 4. Trace and fracturation of the Oligocene—Miocene subduction S_2.

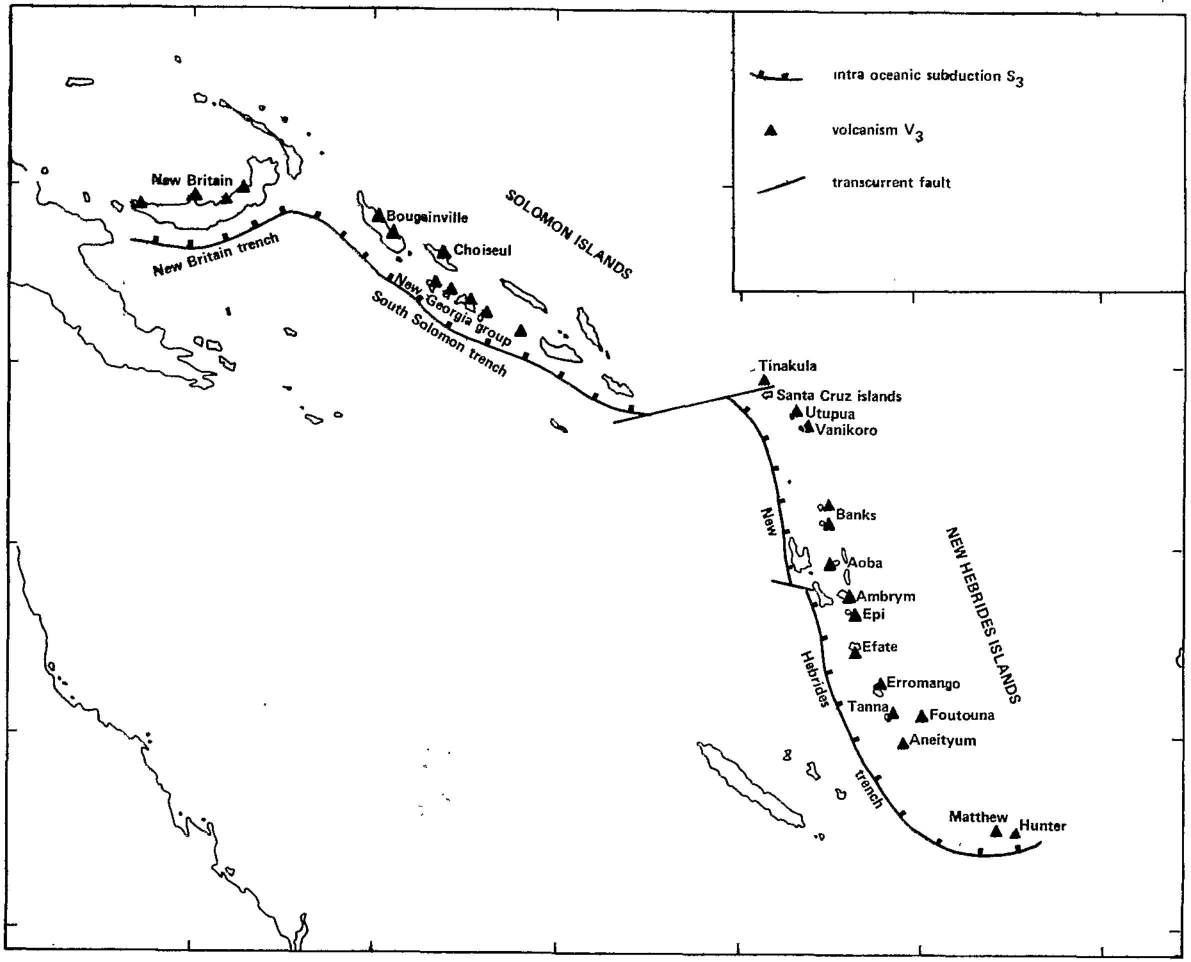

Fig. 5. Trace and fracturation of the Pliocene—Present subduction S_3.

direction of plate motion, appears in the northern part of the studied area. The west Melanesia, North Solomon and Vitiaz trenches are the evidence of this subduction (Chase, 1971; Karig and Mammerickx, 1972; Coleman and Packham, 1976; De Broin et al., 1977) which would be related to the uplift of ophiolites in the Solomon islands. This subduction would have started in the Upper Oligocene and would have stopped at the end of the Middle Miocene (Chase, 1971), round about 12 m.y. ago or more recently (Jezek et al., 1977), because of the arrival of the Otong Java Plateau and the Pacific Border Plateau in the trench (Kroenke, 1972). This motion, illustrated by Fig. 6, has to be related with the anticlockwise rotation of the Melanesian area suggested by Van der Linden (1969) and directly observed in Guadalcanal (Hackman, 1973). The volcanism (V_2) of the Vitiaz arc related to this southward-dipping zone has been described previously; it extends in Fiji (Gill, 1970; Coleman and Packham, 1976; Carney and MacFarlane, 1978) and in the New Hebrides (Maewo)(Carney and MacFarlane, 1978).

The recent and actual subduction (S_3)

Since 7 m.y., the E—W plate motion has induced a final subduction (S_3) (Fig. 5) that dips northwards in the Solomon islands area (Denham, 1969, 1973; Jakes and White, 1969) and eastwards in the New Hebrides (Dubois, 1969; Pascal, 1974; Louat, 1977; Pascal et al., 1978) where the basic ultrabasic formations have been uplifted (Coleman and Hackman, 1974, Mallick and Neef, 1974).

CONCLUSIONS

The geotectonic evolution of the southwest Pacific has been marked, since the beginning of the Tertiary period by three consecutive intra-oceanic subductions. These subductions are more or less consistent with the evolution of the West Pacific proposed by Hilde et al. (1977) and the model advanced by Hughes (1978).

In New Caledonia and Papua-New Guinea, the first subduction has induced the thrusting of ophiolitic assemblages on to continental crust portions. The presence of amphibolites and blue schists in the ophiolite-related metamorphic soles has to be connected to this phenomenon. The metamorphic soles would be provided from the metamorphism of volcanic and sedimentary series of the upper level of the oceanic crust when they were engaged in a subduction zone. In the Solomon islands and the New Hebrides, this first subduction, that did not involve continental crust, has created from the same original material both amphibolites and green schists. The almost similar age of the metamorphism implies an unique subductive event.

The breaking up of the Eocene ophiolitic belt by means of transcurrent

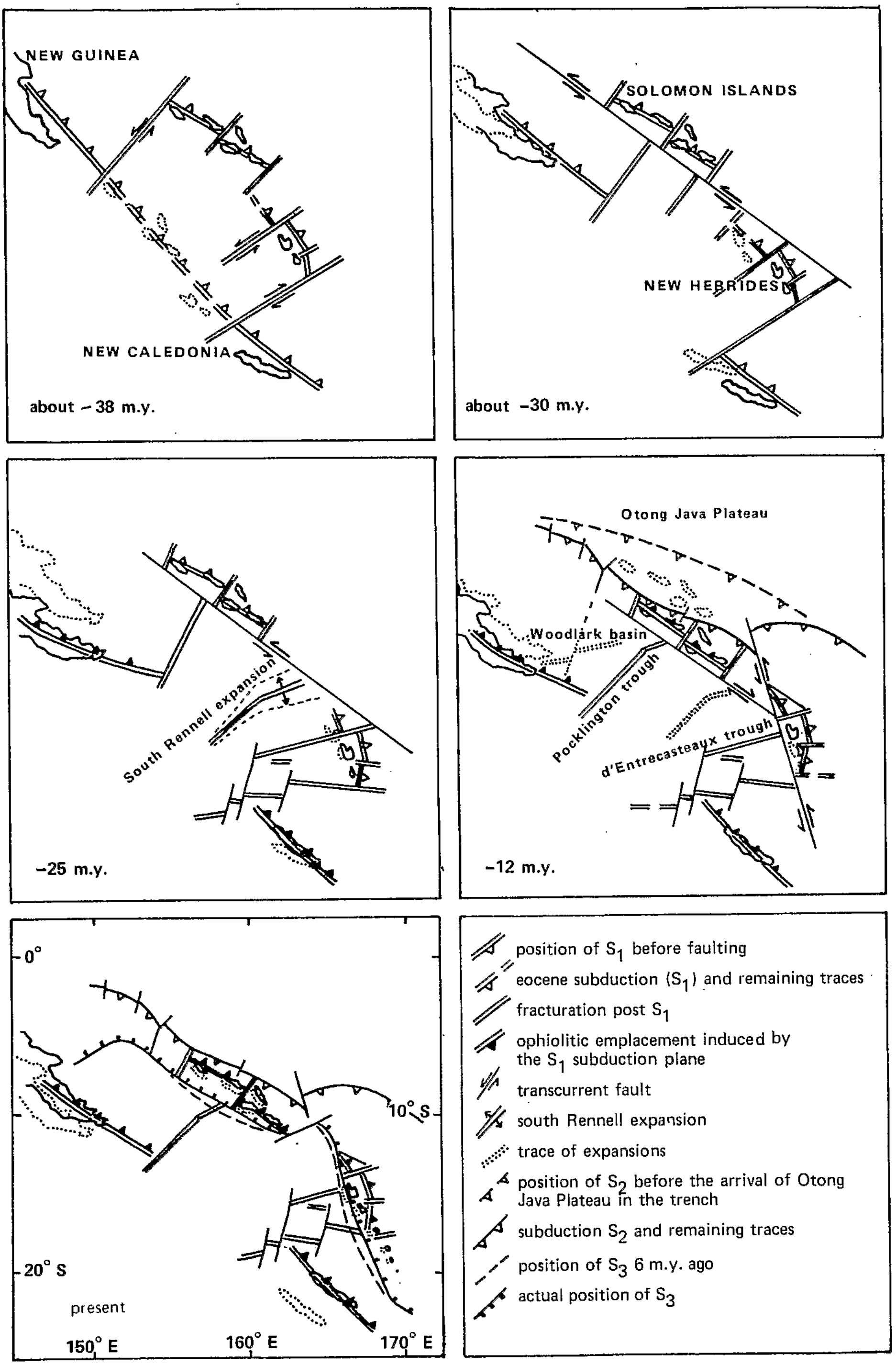

Fig. 6. Reconstitution of the Eocene ophiolitic belt of the southwest Pacific. The position of the islands at the previous time is shown by the dotted line.

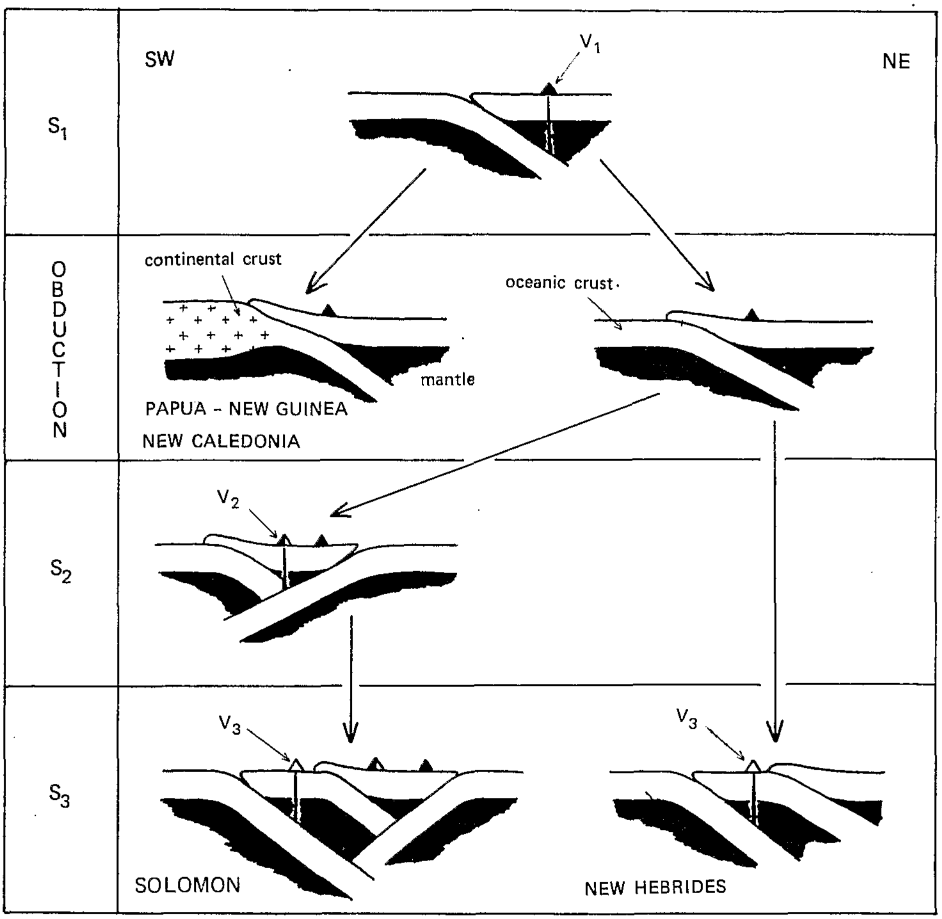

Fig. 7. Schematic cross-section showing the position of the three subductions in the southwest Pacific area.

faults and rotary motions of various ages masks its real continuity (Fig. 6).

New Caledonia and Papua-New Guinea, which have been subject to a westward displacement with respect to the Eocene subduction trace, are not affected by the further subductions (Fig. 7).

In the New Hebrides, the actual subduction plunges with a constant eastward dip underneath the Eocene subduction plane; the ophiolite uplift in Pentecost Island would result from this last event, in relation to the arrival of the d'Entrecasteaux rise in the trench (Fig. 7).

In the Solomon islands, the ophiolitic belt would have been uplifted by an Oligo-Miocene subduction having a southward dip, before the start of the third subduction that actually dips northwards (Fig. 7).

ACKNOWLEDGEMENTS

We thank A. MacFarlane and J. Carney for their helpful criticism of the manuscript.

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