RECENT FAULTING IN COASTAL ZONE OF VIET NAM AND ITS RELATION TO SEISMIC ACTIVITIES

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INTRODUCTION

It is obviuosly accepted in recent years that strong seismozones in Viet Nam are active fault lines [4,10], however, seismohazard-produced ability of the faults is differentiated by fault mechanics and by hazard susceptibility of the region [1,7]; this problem needs to be investigated in detail because of its bearings on environmental management and hazard-reduced planning.

Fault mechanics depends on Recent Tectonic stress Field (RTSF). As to be showed afterwads, the RTSF is in fact not a uniform thing but strongly varies from area to area in Viet Nam.

There are many kinds of hazard susceptibilities in Vietnamese Coastal Zone (VNCZ-or CZ in short), the most noticeable kind is liquefaction susceptibility related to old lagoonal deposits already covered by younger unliquefied ones.

I. THE RTSF AND MECHANICS OF RECENT FAULTING IN VNCZ (FIG.1).

Nguyen Trong Yem (1991) proved that the RTSF in Red River Basin is of strike-slip field with $\sigma 1$=00.00 (submeridional-subhorizotal maximum compressional axix $\sigma 1$) [10]. This RTSF also acts on Red River fault Zone in Western Yunnan-China, causes dextral motion of NW fault sets [2,12], and is produced by northwards migration of india Landmass [12].

This RTSF operates downsouthwards up to around Hue, and had an effect on Quaternary basalt flows in the shore zone of Vinh Linh. Recent faults crosscut basalt right prisms and created the rotation of the basalt prisms inside the deformed zone of the faults [6].

The RTSF working in Central Viet Nam is quite different from others by the fact that its $\sigma 1$ is set up in subvertical position (normal field fig.2). The stressfield reactivised all older faults of any orientations to be normal. The appearence of the stress field is thought to be related to mantle anomaly, creating the recent uplift of Western High Plateau Block in Central Viet Nam and outpouring of basalts [10,11]. The shore lines from Quang Ngai to Vung Tau are controled by various normal faults [11].

The coastal section from Mong Cai to Hai Phong, NE Viet Nam has been affected by other strike-slip field. This RTSF earns $\sigma 1$ = 90.00 (subparallel-sub horizontal maximum compressional axix. NE trending faults there from and dextral, and normal faults corosscuting Late Pliocene lakebeds are E-W directed. The Hai Phong Holocene Basin is located in the transitional position between 2 RTSF : one with $\sigma 1$=00.00 in the southwest and other with $\sigma 1$=90.00 in the northeast [5].

Northeast trending faults in NE Viet Nam have ever been called Dong Trieu Fault System fo years [4, 13, 14]. They are southwest extension of Tan-lu Pault Zone (TLFZ) runnin northeastwards up to Hong Kong-Shang Hai China. The operation of the TLFZ is originate from plate collision process in Western Pacific [8], not only for the recent tectonic phase, bu for whole Meso-Cainozoic history-if not earlier-as well.

The very interesting problem deals with recent fauting in Da Nang region. Red Rive F.appears northeastwards of Son Tra peninsular and Hai Van Pass, its representative on land i Hai Van-Son Tra Fault Zone (HSFZ) with the trends varies around 140^{o}-150^{o}. The HSFZ is se in dextral motion, but is crosscut and stopped by a set of subparallel dextral faults such az C De Fs., Tuy Loan River Fs.

Looking northwards in southern Hue, some other E-W oriented faults as Hue F., Rao Tran F.are also dextral or dextroreverse.

If these E-W faults are created by RTSF as the same of that of Red River FZ ($\sigma 1$=00.00) they should be reverse or thrutst. As a matter of facts, these dextral E-W faults must be operate by a different RTSF with $\sigma 1$=140-150.00. They produce many faultscarps with slope angles o more than 50^{o}. These faultscarps are still fresh, containing many landslides and rock avalanches and crosscuting through Early Pleistocene Pediment.

The above facts clearly proved that Red River Fault System and its RTSF have bee terminated around Da Nang Parallel where other fault system and related RTSF have bee replaced. Beside that. Da Nang Parallel is the interchange field between Red River F. and Eas Viet Nam F; the latter during the whole openning history of East Viet Nam Sea Basin (EVNSB had ever been a dextral fault. In recent tectonic period, its activity is surely related to closing o EVNSB. Judging from the direction of recent ridges and thrusts affected to Late Pleistocen deposits in Truong Sa (Spratley) archipelago [3,9], the shorterning process must b originated from a RTSF with $\sigma 1$=140-150.00 as he same thing governed in Da Nang region The East Viet Nam Fault, therefore, should be sinistral respectively.

II. RELATION BETWEEN ACTIVE FAULTS AND SEISMIC HAZARDS IN VNCZ.

Distribution of seismogenic zones and related earthquakes (M,I,h) in Vietnamese territory an offshore areas have been elucidated for years by Nguyen Can and by his colleagues [4,13]. B the combination of characteritics of already known seismogenic zones with new understanding about RTSF and mechanics of the earthquake-produced faults, its is able to draw up some roug estimates on the relationship between active fault and seismic hazards in VNCZ as followings:

1. Most-if not all-Earthquakes in VNCZ are produced by FAULTING:* NORMA FAULTING governes in Western High Plateau Block (Tay Nguyen Block) caused by uplift. STRIKE-SLIP FAULTING-caused by palate collision forces accumulated in Himalaya to th west or in Pacific to the east-acts in other regions of the country.

* Normal faulting relates to earthquakes with 5.1<M<5.5.
* Strike-slip faulting may give earthquakes with magnitudes ranging up to 7.

2. Faul-generated earthquakes as usual are shallow-focus. Acording to Lundgren [7] the displacement of both sides of a given fault transfers energy from the earth interior to accumulation zones; the latter located in the upper 15 km where two blocks on either side of the fault are LOCKED, while the lower parts of theses blocks may move smoothly past one another forcing the overlying parts to move in the same direction, the process must result in strain accumulation in the upper part to form an asperity (high strain zone) on a potential rupture zone. The rate of calm slip on the undersection of the fault accelerates to increase the shear stress close to the potential rupture plane uptill the happening of the main shock to release most of the strain in the asperity.

Most of fault-related earthquakes, therefore, must be shallow events with hypocenters commonly located on the upper part of the faults (it means around 15 km deep from ground surface). The 15 km deep boundary is still not well known, this causes the rotation of blocks in the deformed zone of strike-slip faults, the main kind of intraplate deformation, this causes the ability to slip smoothly of blocks lying deeper 15 km from ground surface.

Depth of the recorded earthquakes in VNCZ varied from 10 to 30 km [13], some hypocenters deeper than 15-20 km should be rechecked respectively.

Fault-related earthquakes in VNCZ are of Mmax between 5.0 and 7.0, [4, 13], but commonly of M max between 5.0 and 6.0 [4,13] in the cases of shallow earthquakes (h<15km), severe disasters may be actual. In VNCZ, there exist Holocene lagoonal sequences in many localities which nowaday underlie younger deposits. The well sorted finegrained sands and muds of the lagoonal sequences may be liquefied. The liquefaction may magnify seismic waves, create sand boils, turn weak earthquakes to disasters.

PRELIMINARY CONCLUSION

Most of-if not all-strong earthquakes in the coastal zone of Viet Nam are obviously created by active faulting, especialy by strike-slip motion of the recorded magnific fault. Fault-related earthquakes are shllow focused, may be disasters caused by liquefaction of old lagoonal deposits in coastal lowlands.

FIGURE CAPTIONS

Figure 1.Stress trajectory in combination with seismogenic zones and fault mechanics :

1- $\sigma 1$ = 90.00 ; NE directed Fs.: dextral ; 5.6<M<6, I^0 = 8

2- $\sigma 1$ = 00.00 ; NW directed Fs.: dextral ; 5.1<M<7, I^0 = 7 + 8.9

3- $\sigma 1$ = 140.00; EW directed Fs.: dextral ; 5.1<M<5.5, I^0 = 7

4- $\sigma 1$ = **.90 ; normal Fs.variously directed ; 5.1<M<5.5, I^0=7

Figure 2. Stereographic diagrams of active faults in some selected sites.

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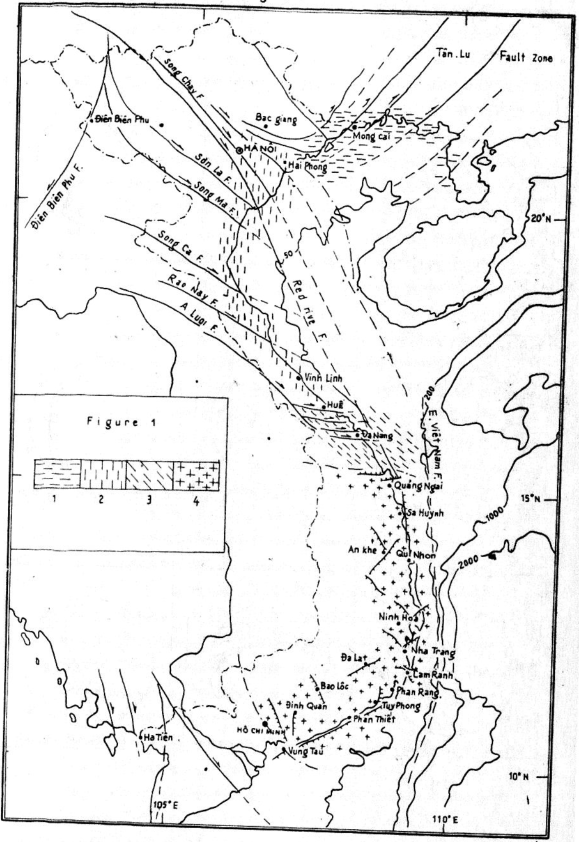
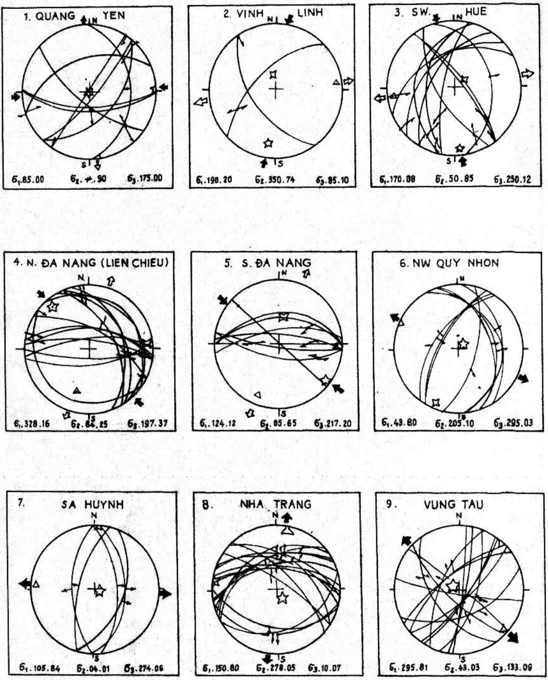
Figure 1



Tân . Lu
Fault Zone
Song Chay F.
Bac giang
Mong cai
Điên Biên Phu
HÀ NÔI
Hai Phong
Sơn La F.
Song Ma F.
Điên Biên Phu F.
20° N
Song Ca F.
50
Rao Nay F.
Red rive F.
A Lugi F.
Vinh Linh
200
Huê
Figure 1
Đa Nang
E. Việt Nam F.
1
2
3
4
Quảng Ngai
15° N
Sa Huỳnh
1000
An khe
Qui Nhon
2000
Ninh Hoà
Nha Trang
Đa Lat
Lam Ranh
Bao Lôc
Phan Rang
Đinh Quan
Tuy Phong
Phan Thiêt
HÔ CHI MINH
Ha Tiên
Vung Tàu
10° N
105° E
110° E

FIGURE 2



1. QUANG YEN
N
S
σ_1.85.00
σ_2.+.90
σ_3.175.00
2. VINH LINH
N
S
σ_1.190.20
σ_2.350.74
σ_3.85.10
3. SW. HUE
N
S
σ_1.170.88
σ_2.50.85
σ_3.250.12
4. N. ĐA NANG (LIEN CHIEU)
N
S
σ_1.328.16
σ_2.84.25
σ_3.197.37
5. S. ĐA NANG
N
S
σ_1.124.12
σ_2.05.65
σ_3.217.20
6. NW QUY NHON
N
S
σ_1.43.80
σ_2.205.10
σ_3.295.03
7. SA HUYNH
N
S
σ_1.105.84
σ_2.04.01
σ_3.274.06
8. NHA TRANG
N
S
σ_1.150.80
σ_2.278.05
σ_3.10.07
9. VUNG TAU
N
S
σ_1.295.81
σ_2.43.03
σ_3.133.09

TẠP CHÍ KHOA HỌC, ĐHQG HN, KHTN, t.XI, n°3 - 1995

HOẠT ĐỘNG ĐỨT GÃY HIỆN ĐẠI Ở VEN BIỂN (COASTAL ZONE) VIỆT NAM VÀ MỐI LIÊN QUAN VỚI HOẠT ĐỘNG ĐỊA CHẤN

Nguyễn Cẩn, Nguyễn Đình Hòe
Đại học khoa học tự nhiên, ĐHQG HN

TÓM TẮT

Đại bộ phận động đất ở Đới ven biển Việt Nam đều được gây ra do hoạt động đứt gãy hiện đại; gồm hoạt động đứt gãy thuận, tác động ở đới ven biển Trung Bộ (từ Quảng Ngãi đến Vũng Tàu) do vận động Nâng Trồi (uplift), và hoạt động đứt gãy Trượt Bằng theo phương (Strike-slip) tác động trên các diện tích còn lại liên quan đến vận động Dồn Mảng (collision):

* Hoạt động Đứt Gãy Thuận gây ra động đất với 5,1<H<5,5

* Hoạt động đứt gãy Trượt Bằng Theo Phương liên quan với các động đất 5,1<M<7,0.

Cơ chế đứt gãy và các đặc trưng của động đất (M, I, h) liên kết với đứt gãy phụ thuộc vào trường ứng suất kiến tạo hiện đại (TUSKT) :

* TUSKT với σ1 ~ 90.00 tác động ở đoạn Đông Triều - Móng Cái gây ra các đứt gãy thuận phương Á Vĩ Tuyến và các đứt gãy trượt phải phương đông bắc, TUS này có lẽ là sản phẩm của hoạt động dồn mảng ở phần Tây Thái Bình Dương.

* TUSKT với σ1 ~ 00.00 tác động từ Hải Phòng đến lân cận Huế, chắc chắn liên quan đến sự va chạm giữa lục địa Ấn Độ và Âu - Á, tạo ra các hệ đứt gãy lớn trượt trái phương tây bắc.

* TUSKT với σ1 ~ 140.00 có khả năng liên quan với sự thu hẹp Biển Đông hiện đại, xuất hiện ở đoạn từ Hải Vân đến Quảng Ngãi với các đứt gãy trượt phải phương á vĩ tuyến .

* TUSKT có σ1 ~ *.90 tác động từ Quảng Ngãi đến Vũng Tàu, chuyên tạo ra các đứt gãy thuận, chắc chắn do vận động Nâng Trồi của khối các cao nguyên Tây Nguyên tạo ra.

Động đất liên quan đến vận động đứt gãy hiện đại trong màng thạch quyển cứng thường là loại động đất nông có h < 15km, vì thế mặc dù năng lượng chấn tiêu nhỏ vẫn có thể gây tai biến, nhất là ở đới ven biển thường có loại trầm tích có tính nhậy cảm hóa lỏng cao khi động đất.