Universidad Nacional de La Plata

Mecanismo Focal

Mecanismo de fallamiento

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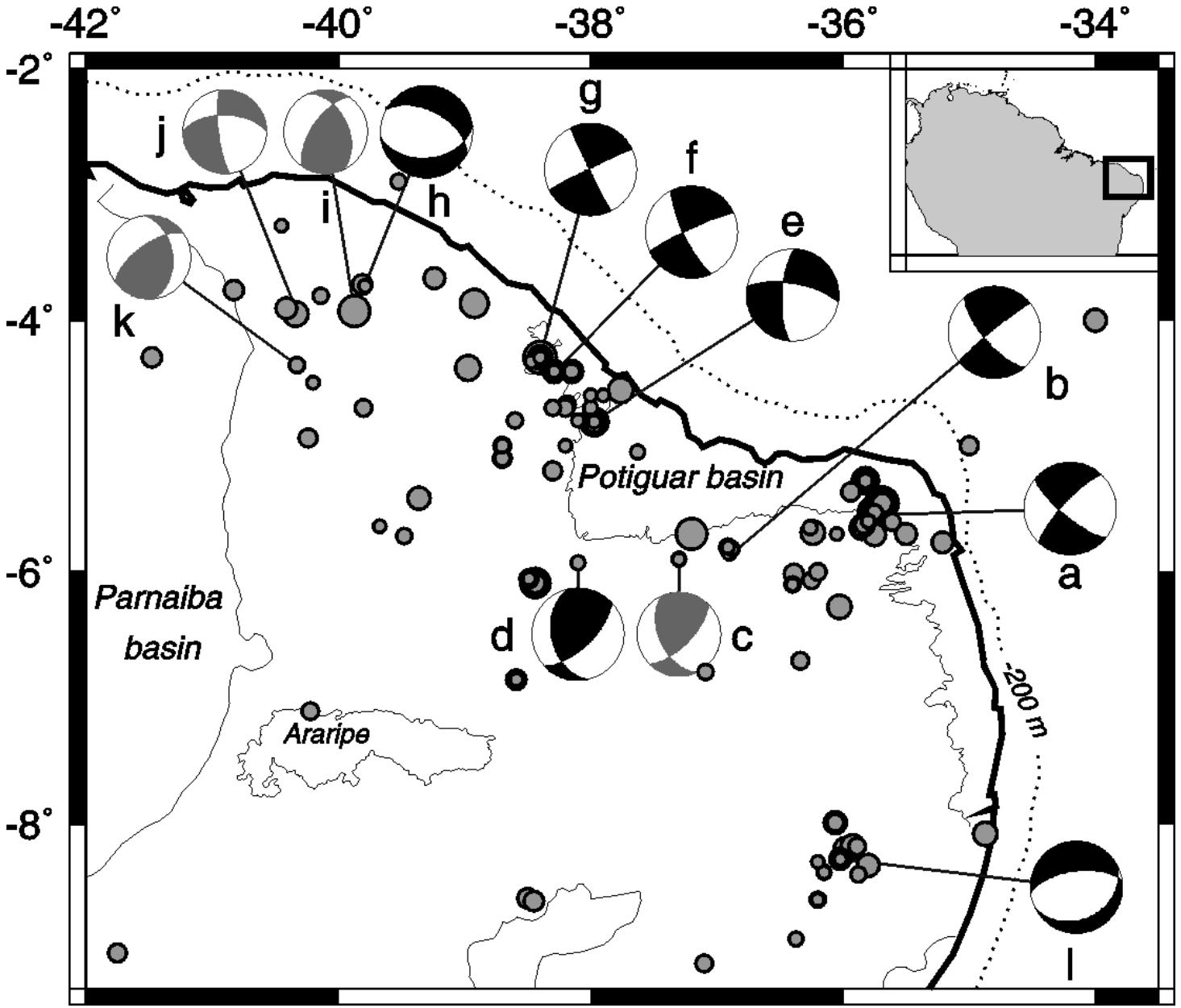
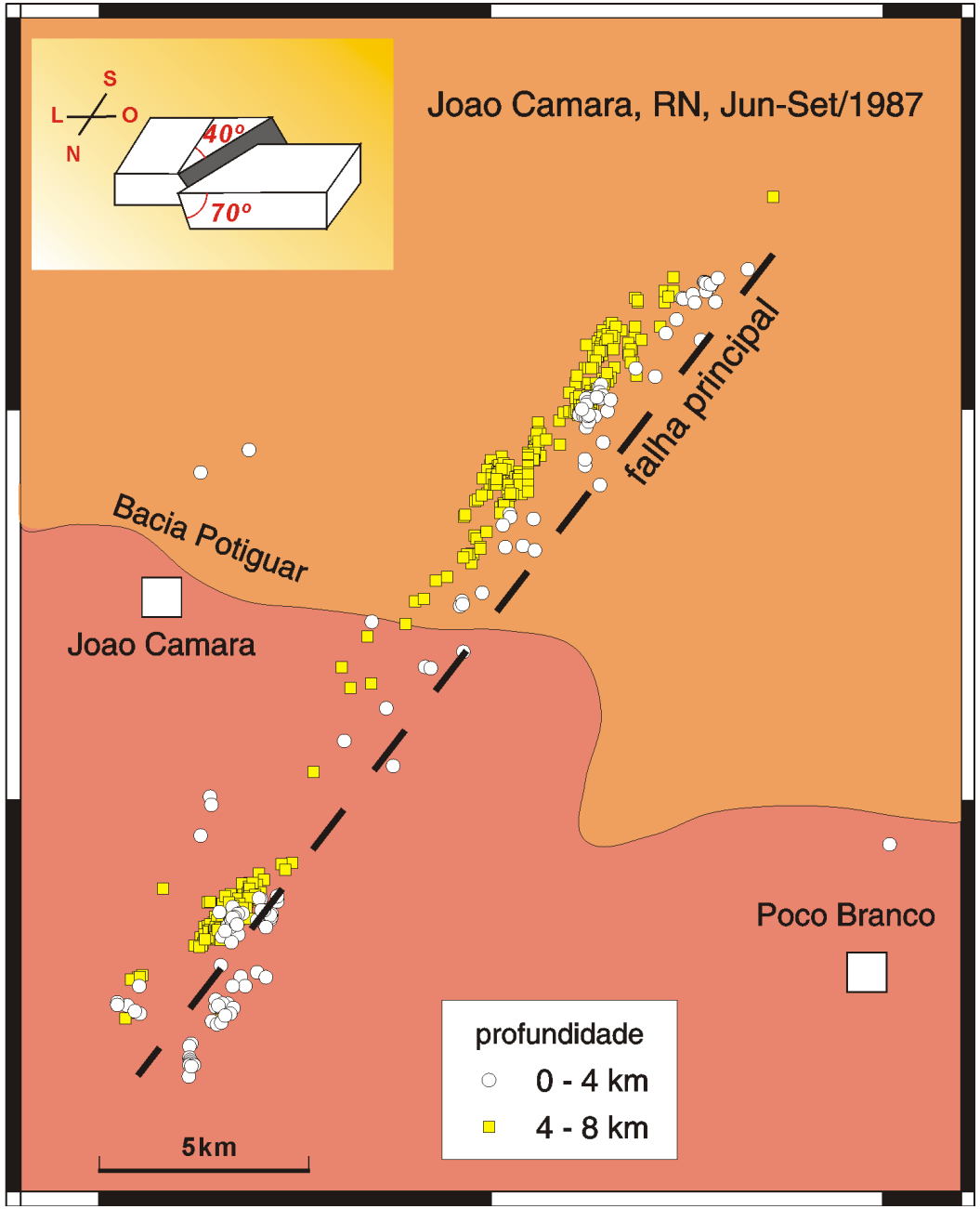
Mecanismos Focales en Nordeste de Brasil



Ferreira et al., (1998)



Mecanismo Focal:

-Determinación de la orientación de la falla (*strike, dip*) y el desplazamiento ("*slip vector*", o "*rake*"). Dirección del esfuerzo que causó el sismo.

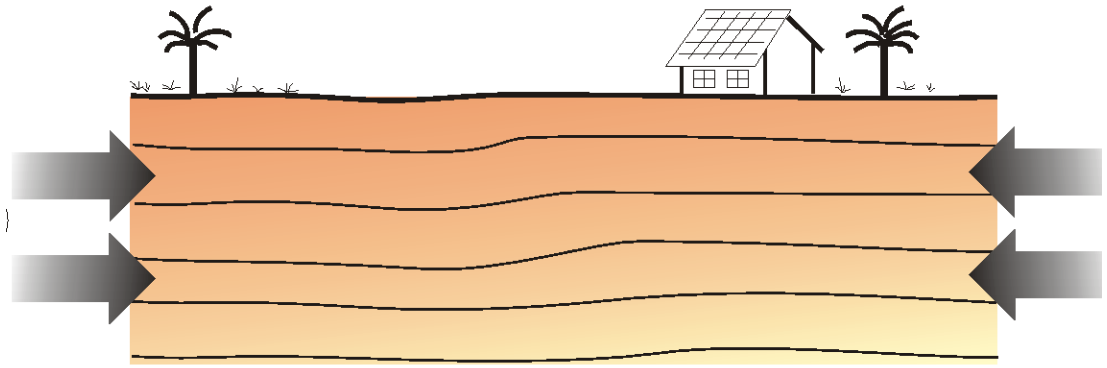
- **A**rea de ruptura del sismo en la falla (**A**)
- Caída de esfuerzo ("*stress drop*")
- desplazamiento promedio ("slip"), **d**

-Momento sísmico

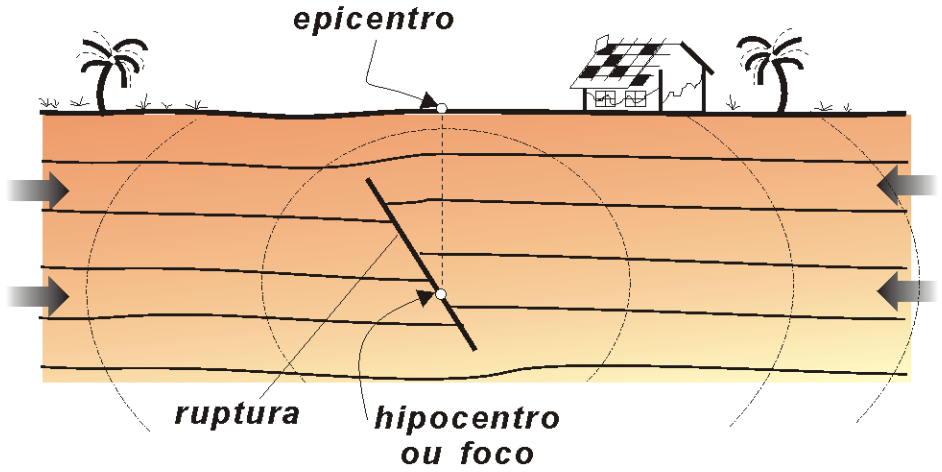
$Mo = \mu \, \mathbf{d} \, \mathbf{A}$

(μ = módulo de rigidez)

"Falla Sísmica de Samambaia", João Câmara, RN, activa desde 1986. Longitud de ~35 km, magnitud máxima 5,1 mb.

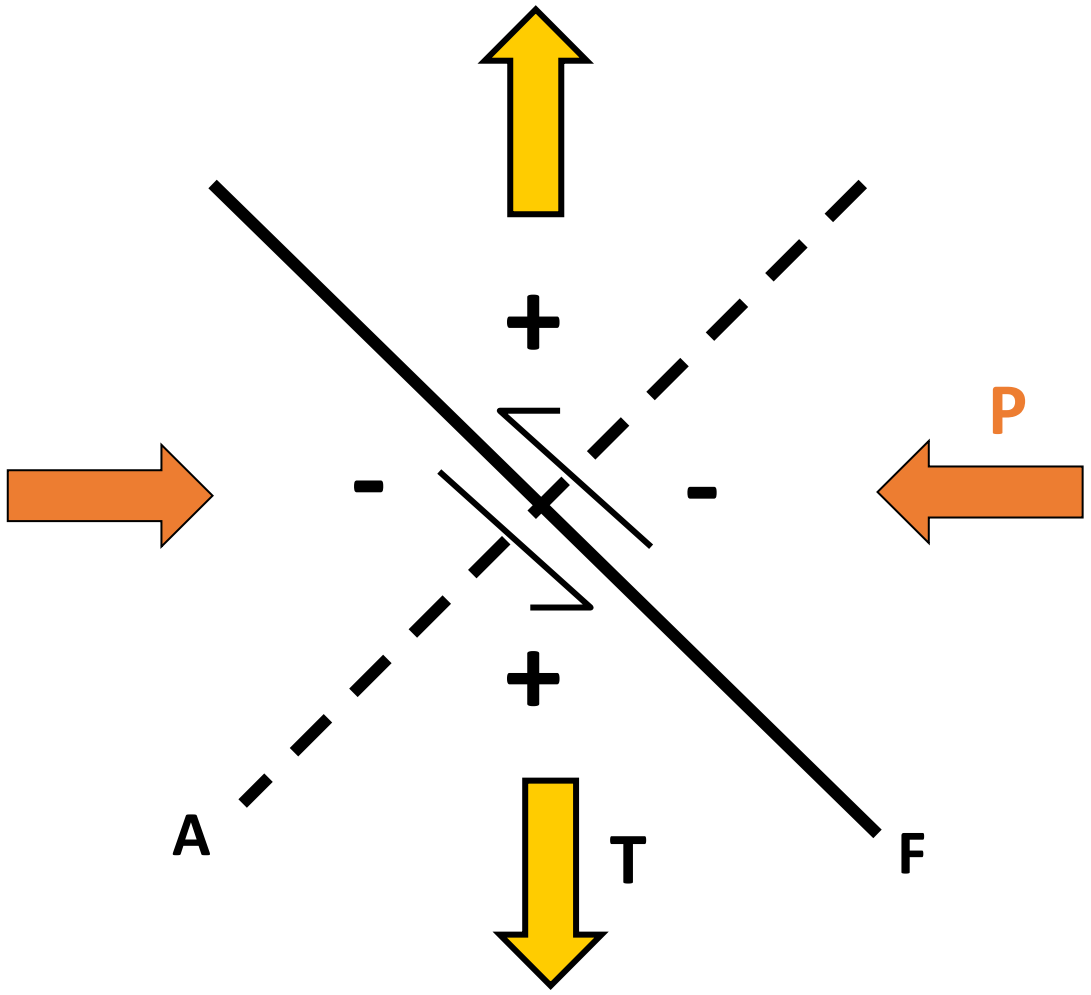


Objectivo: determinar el “esfuerzo tectónico”.



Mecanismo focal puede ser determinado con las ondas sísmicas P, S y de superfície.

Ejes P (presión) y T (tensión)



Onda P: para
frente o p/ trás

+ **-**

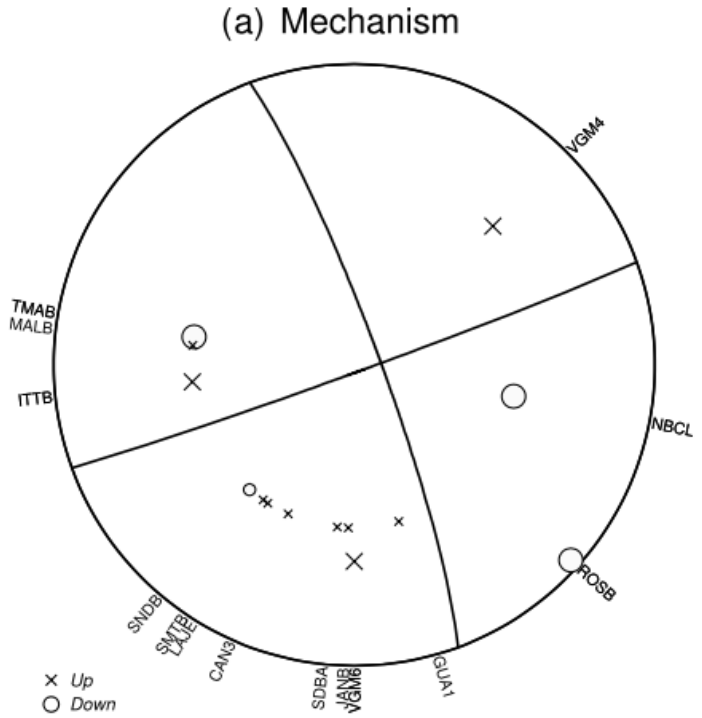
(“compresional”
o “dilatacional”)

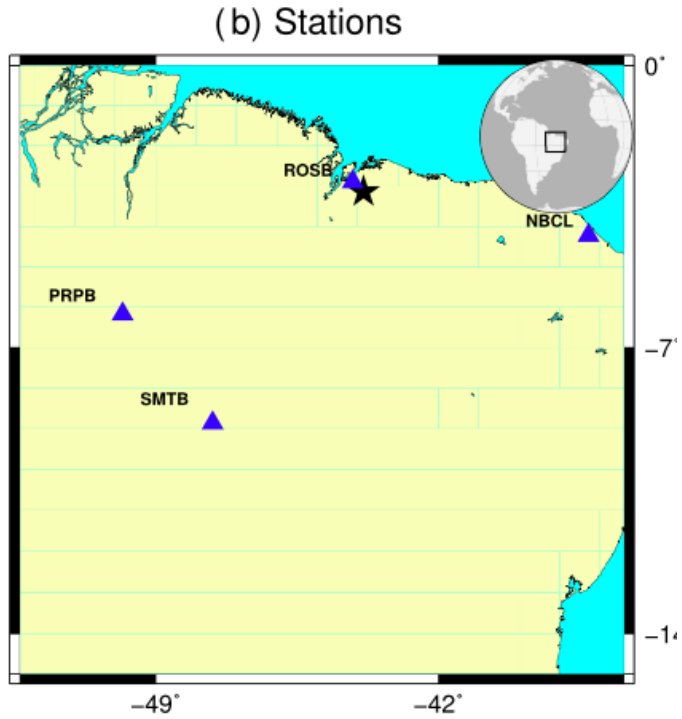
P y **T**

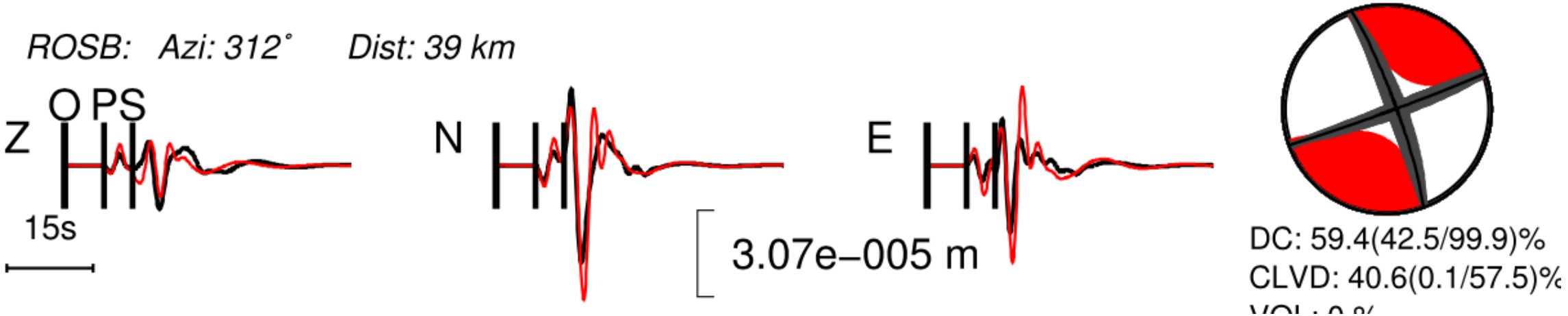
a 45º de los planos
F y A :
esfuerzo **liberado**
pelo sismo

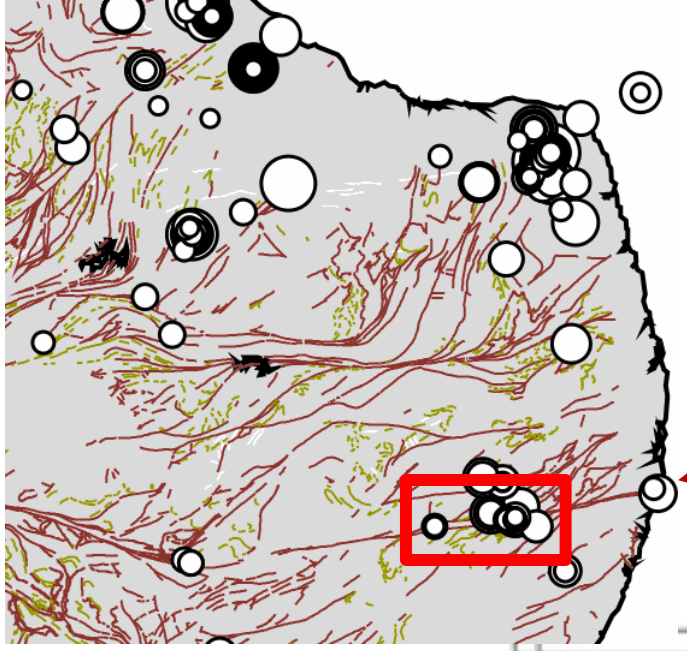
Sismo do Maranhão,
03-Jan-2017 m=4.3

1) No diagrama de polaridades da onda P (ao lado), indique a posição dos eixos P (Pressão) e T (Tração)
2) Para cada opção do plano de faha, diga se o movimento é dextral ou sinistral
3) Coloque os eios P e T na “beachball” abaixo.



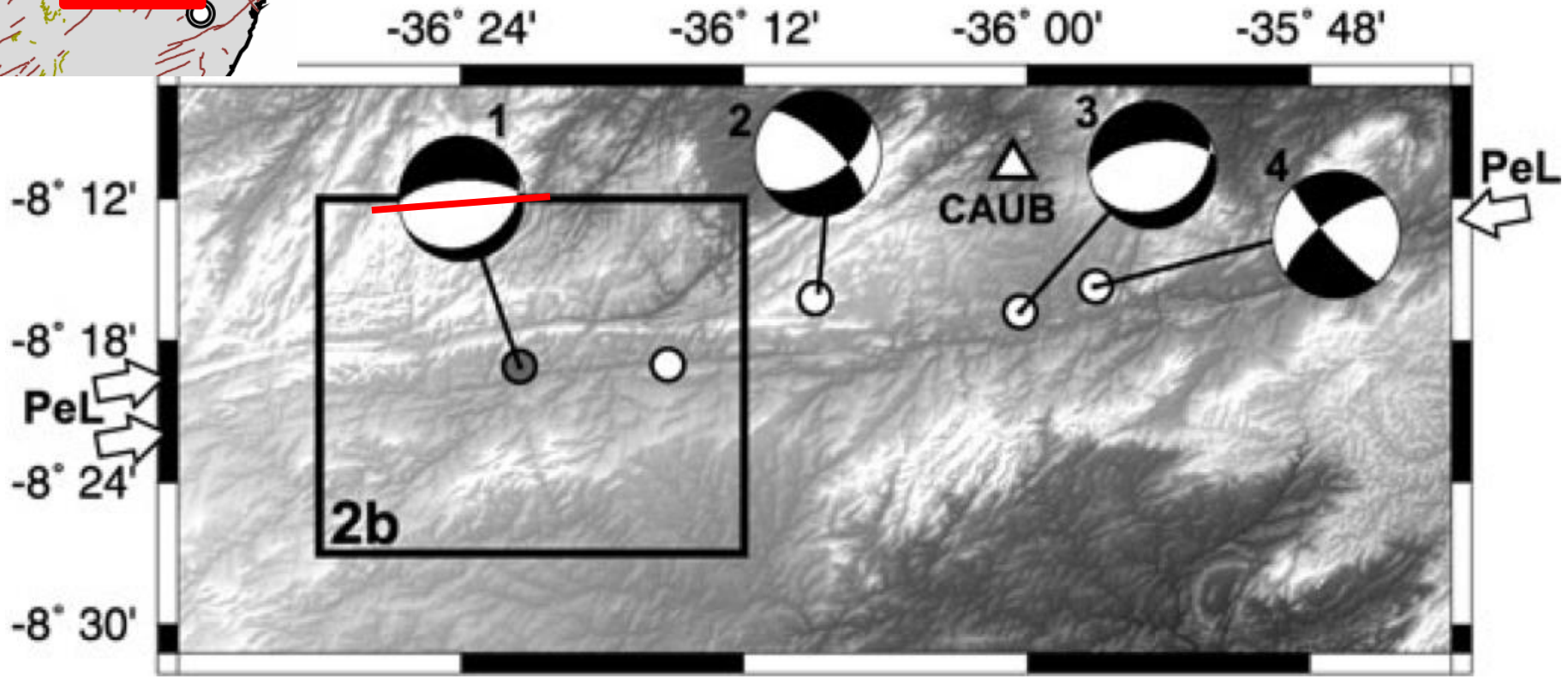






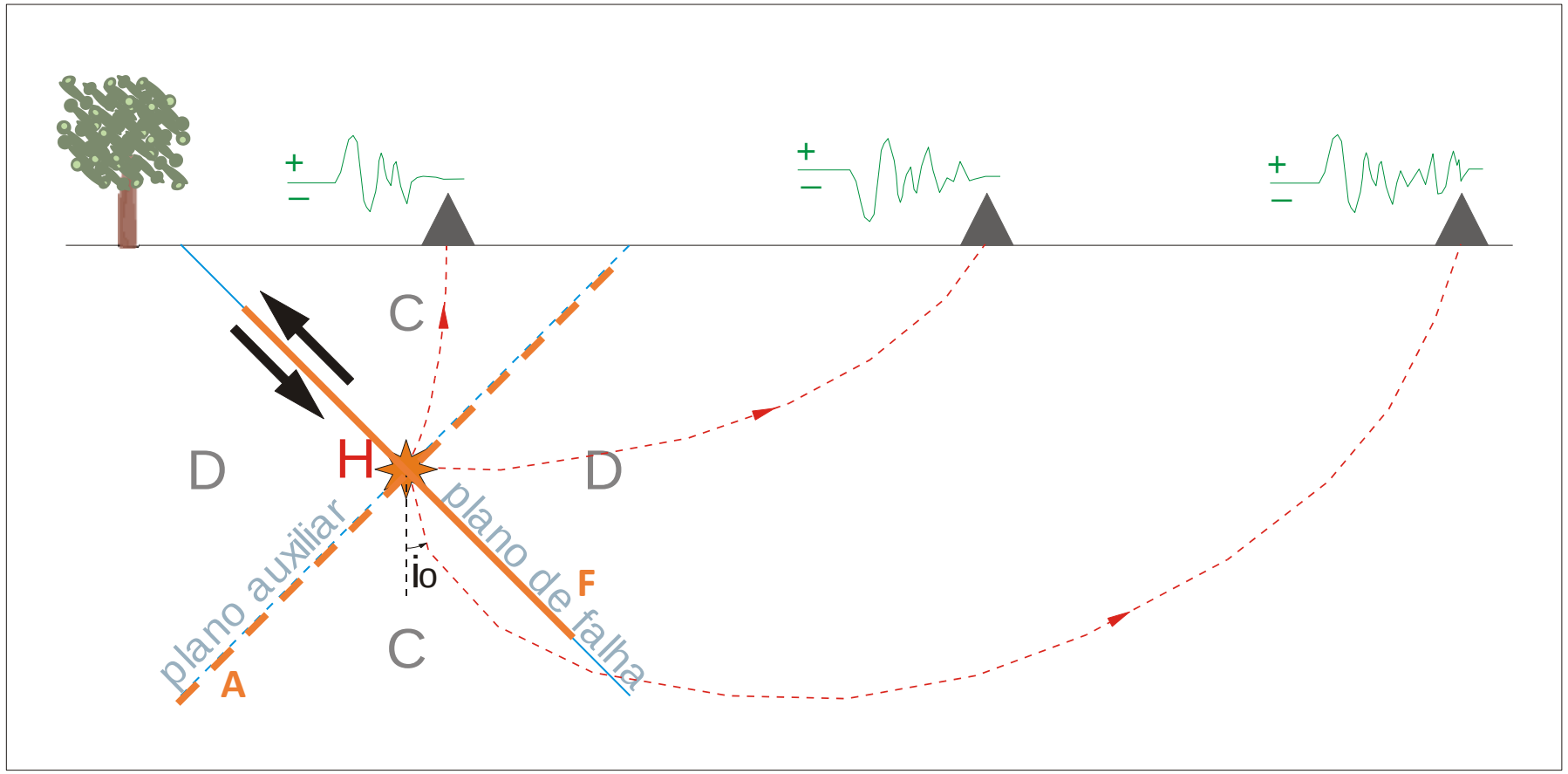
Sismos no Lineamento de Pernambuco: reativação de estruturas antigas mapeadas na superfície (caso raro no Brasil)

Exercício: Para os mecanismos 2 e 4 (falhas transcorrentes), indicar qual dos planos é a falha e a direção de movimentação (dextral ou sinistral). Indicar a direção provável do S1 (compressão máxima horizontal).



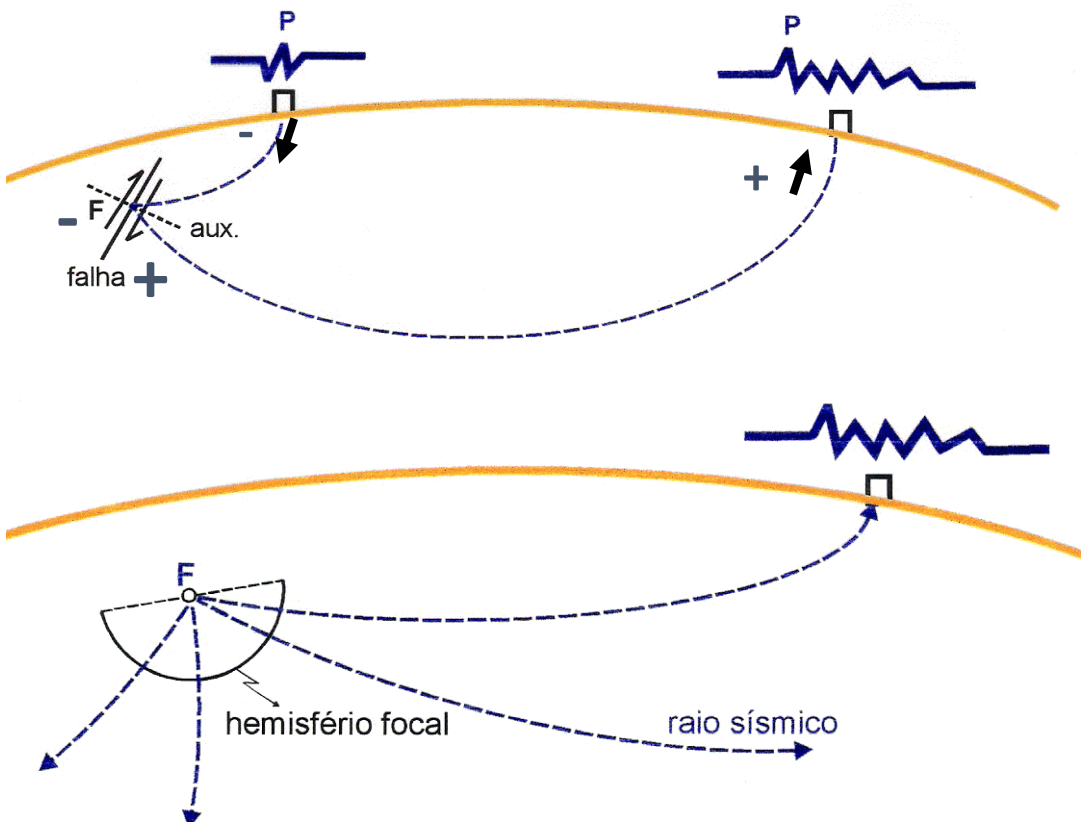
Lopes *et al.*, GJInt, 2010

Ondas P



Mecanismo focal con ondas P

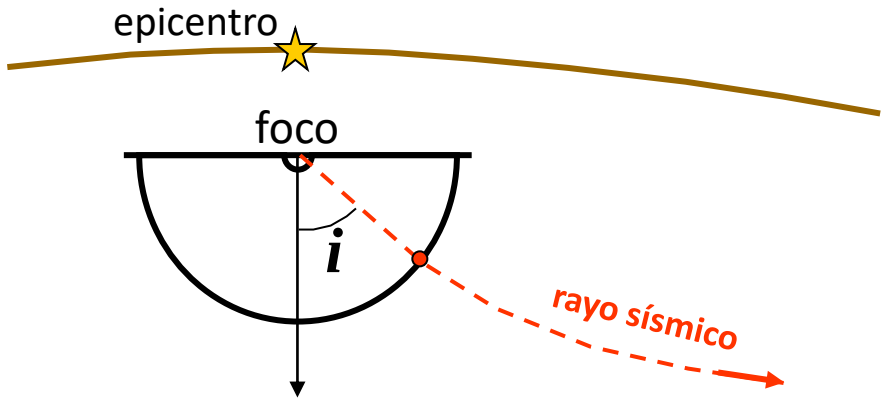
Determinación de los 2 planos (Falla y Auxiliar) que dividen el espacio en 4 quadrantes con polaridades P distintas: <u>empurrão</u> (+) e <u>puxão</u> (-).



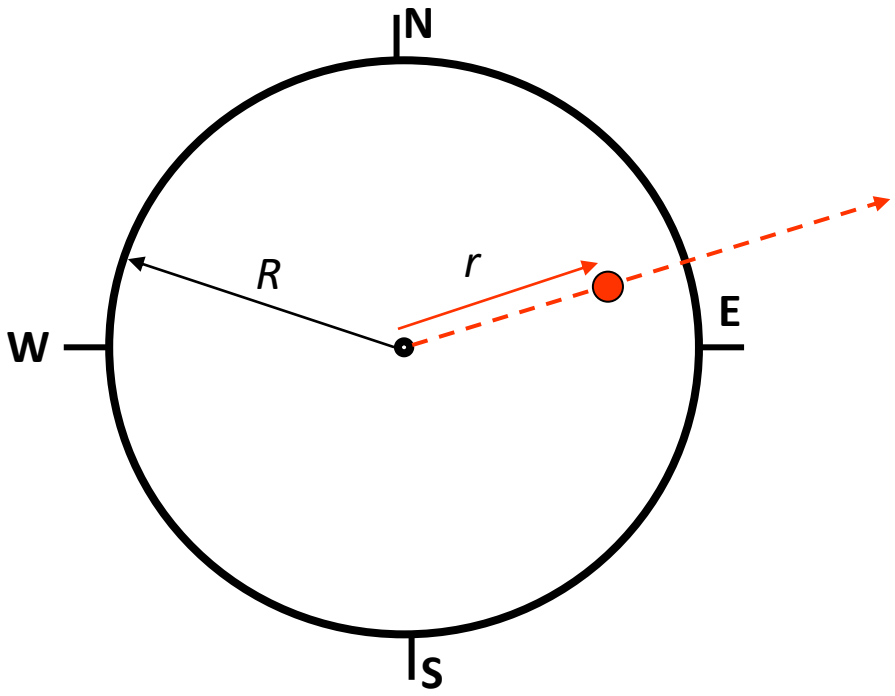
polaridades plotadas en un hemisferio inferior imaginario (suficientemente grande p/ la ruptura ser um “foco”, pero suficientemente pequeña para que los rayos sean rectilíneos.

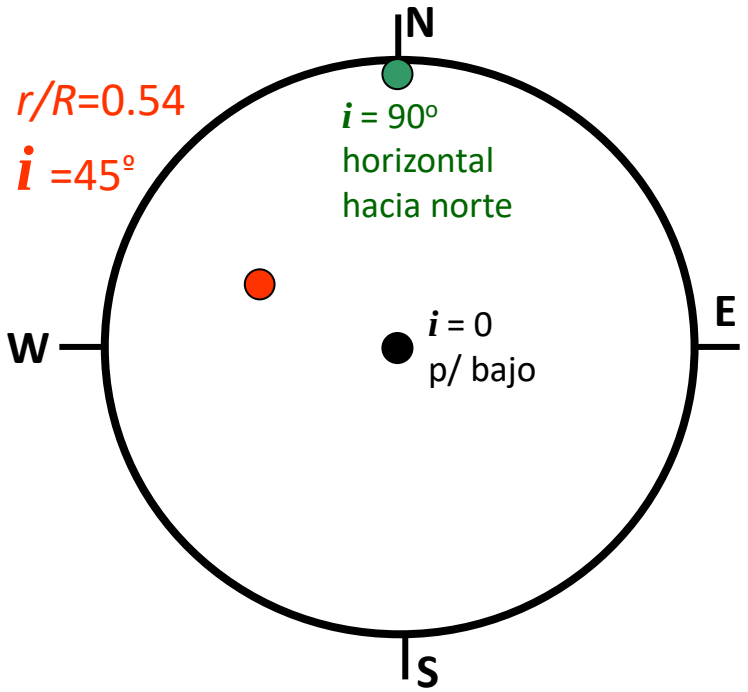
Proyección estereográfica de Schmidt (area–igual)

representación de un rayo con ángulo de salida i



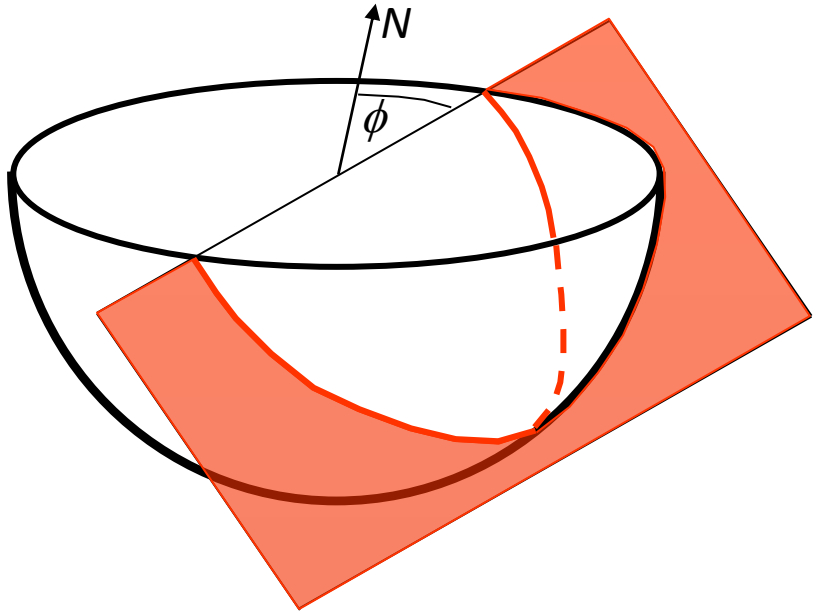
$$r = R\sqrt{2}\sin(i/2)$$

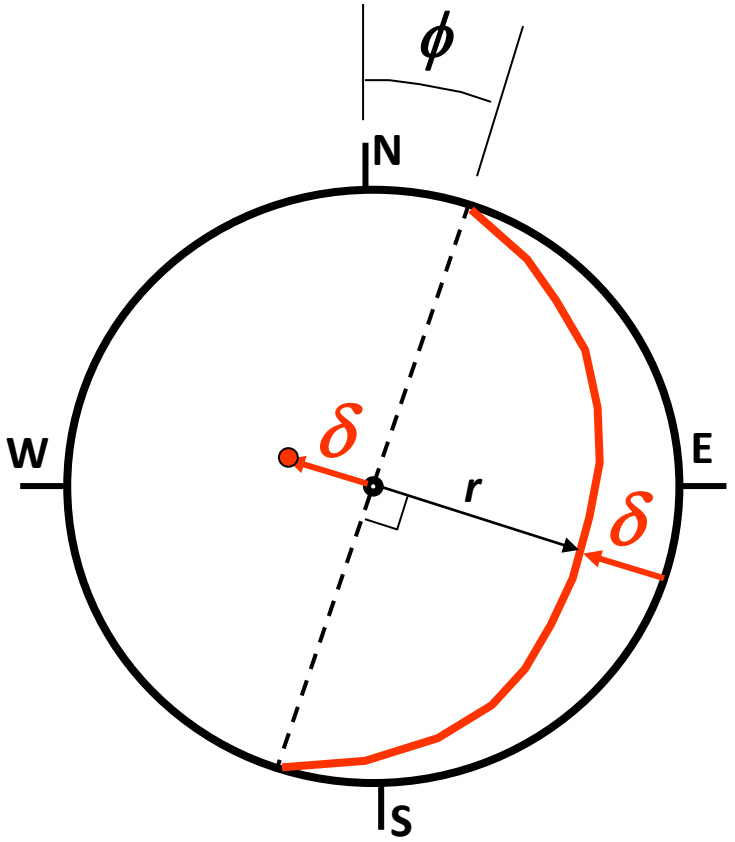


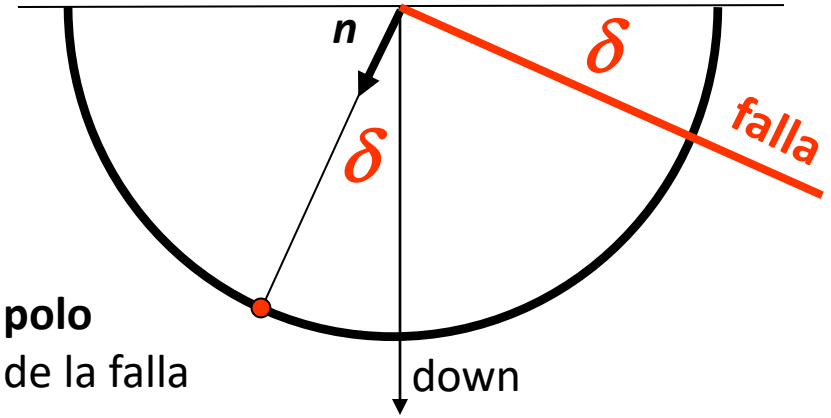


Proyección estereográfica de Schmidt (area–igual)

representación de un plano con buzamiento δ

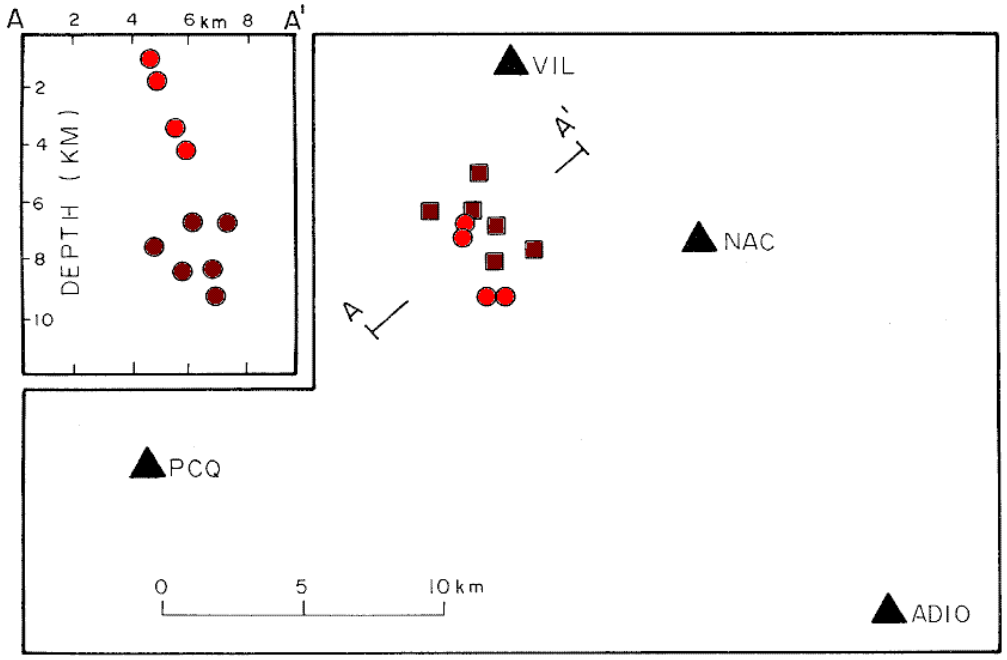


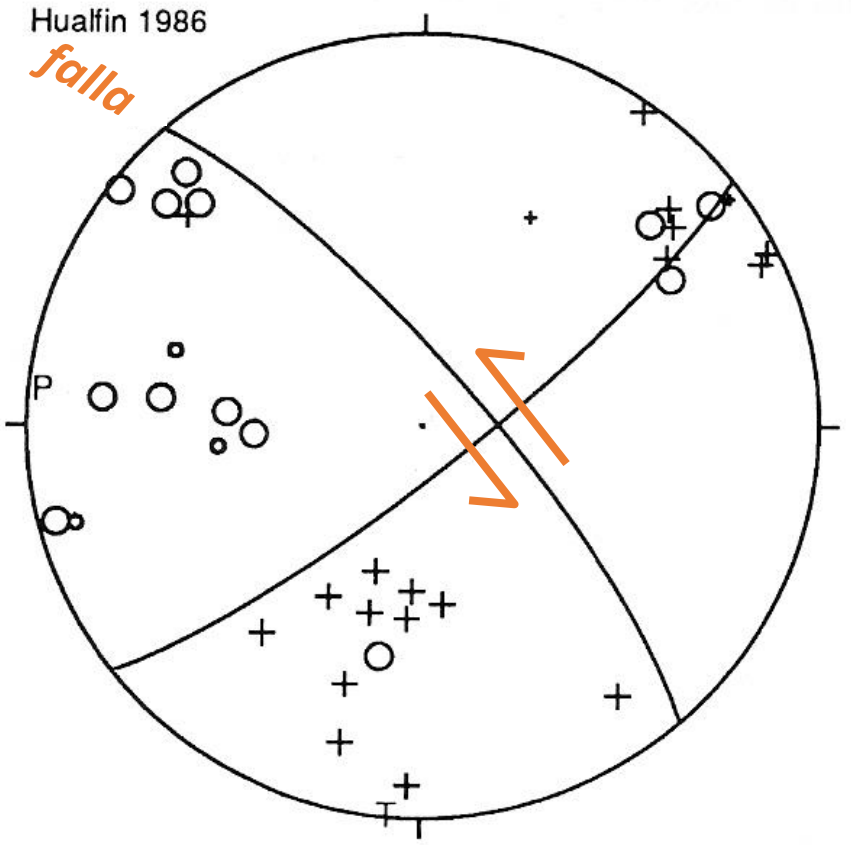




$$r = R\sqrt{2}\sin((90-\delta)/2)$$

Mecanismo Focal de Hualfin, Catamarca, 1986

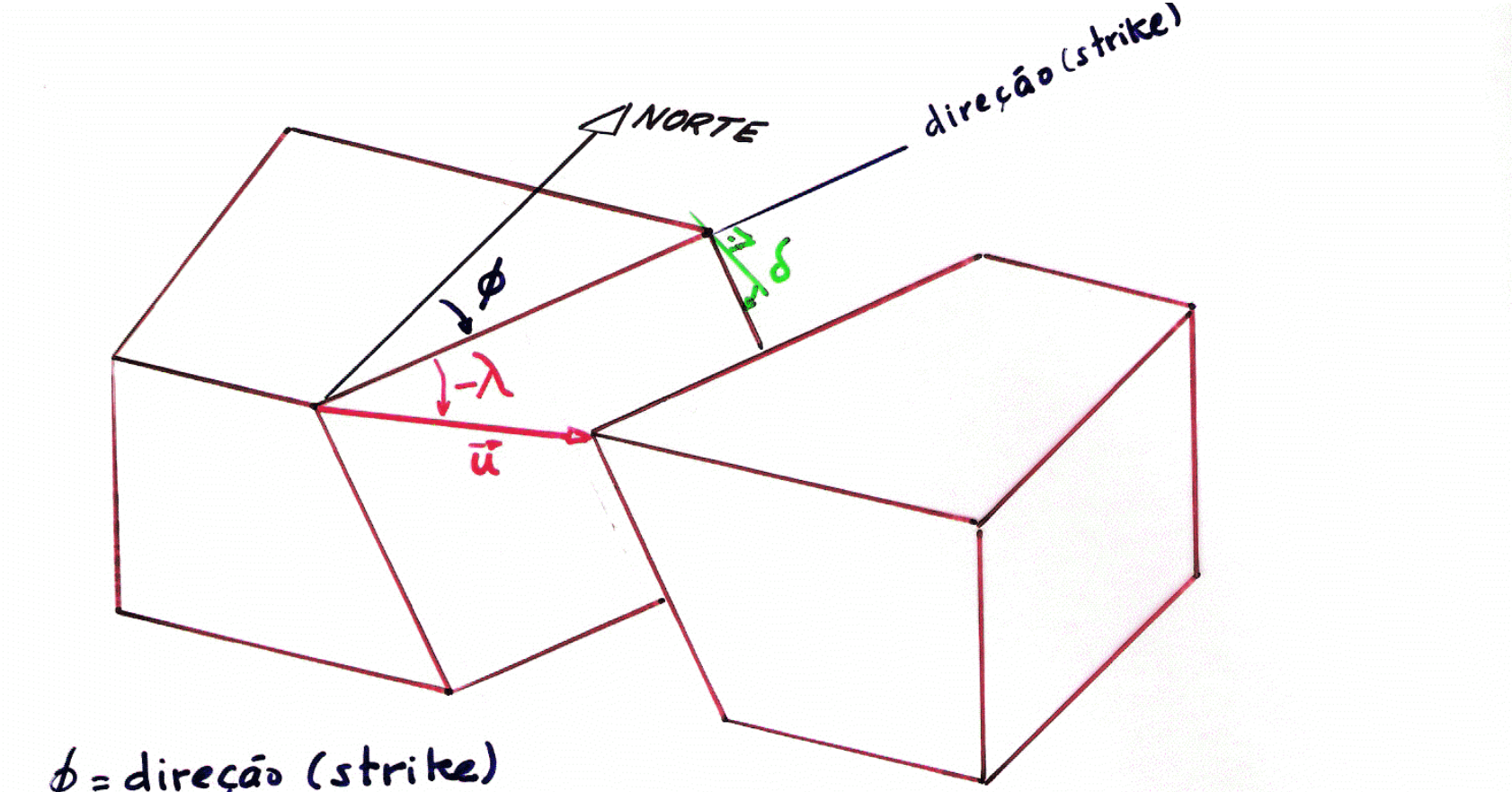




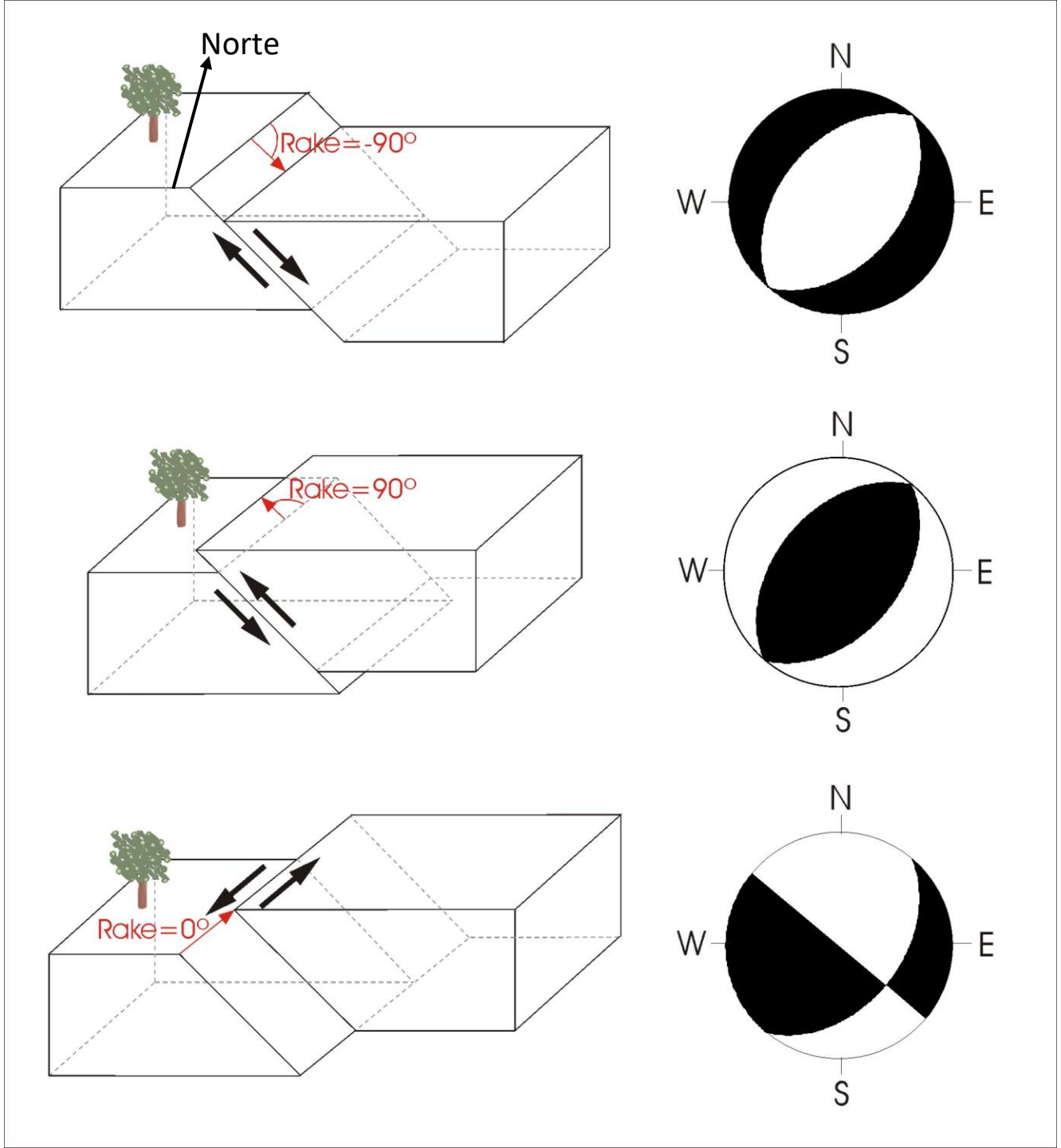
\+ movimiento de la P hacia frente

o onda P hacia atrás

Assumpção & Araujo, 1993



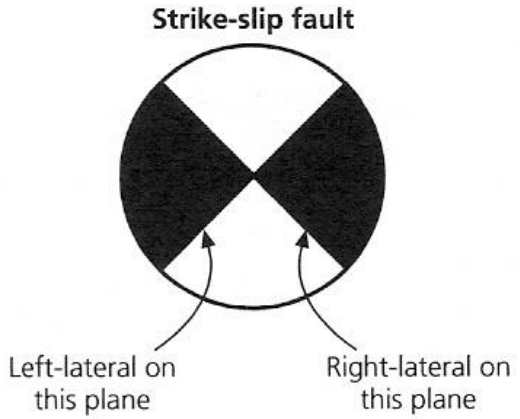
Convenio sismológico:
Dirección del plano (strike, ϕ) tal que el rumbo del buzamiento sea 90º más adelante.
Ángulo del desplazamiento (*rake*, "*slip angle*", λ): de la horizontal p/ arriba: falla inversa: $\lambda > 0$; falla normal: $\lambda < 0$.

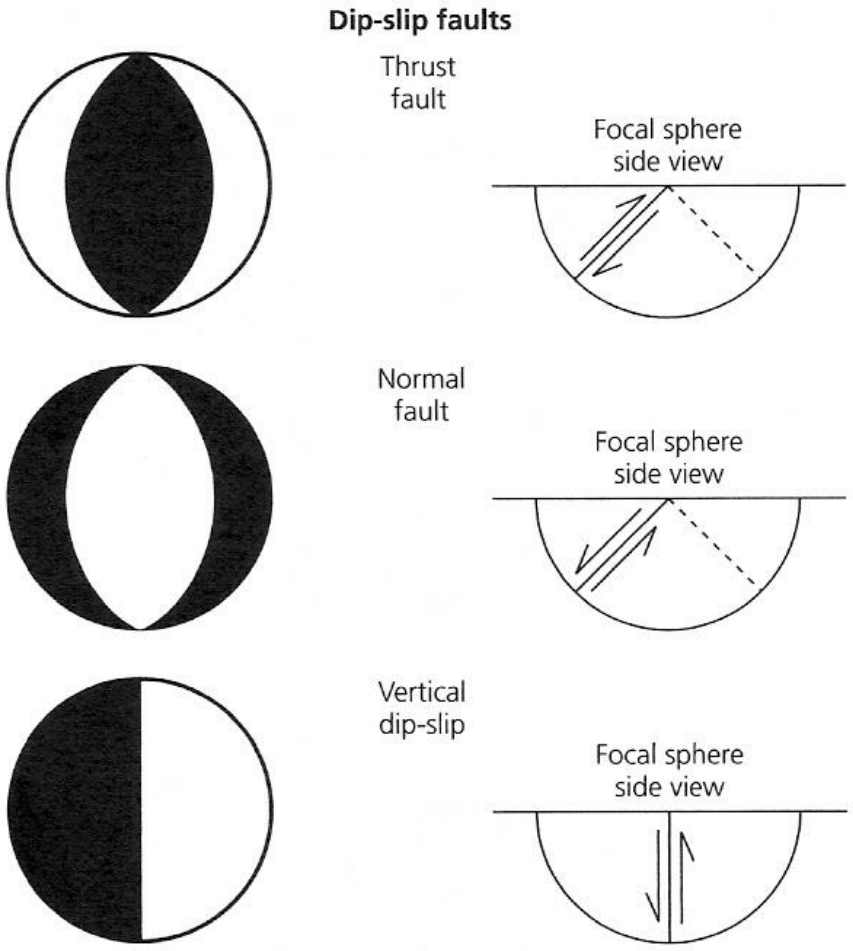


str=45 dip=45 rake=-90

str=45 dip=45 rake=+90

str=45 dip=45 rake=0





Exercício

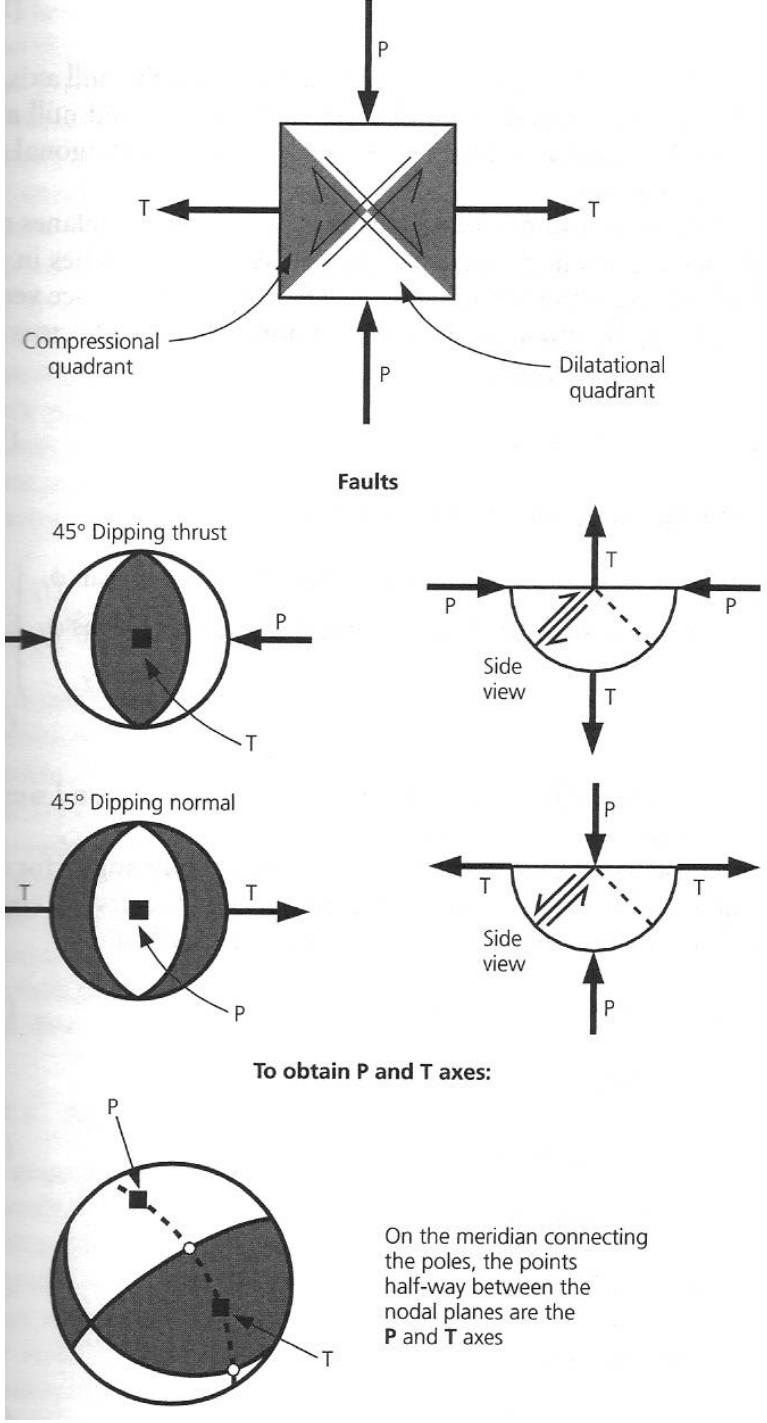
Para cada caso, determinar o strike, dip e rake

180 45 90

180 45 -90

0 90 90

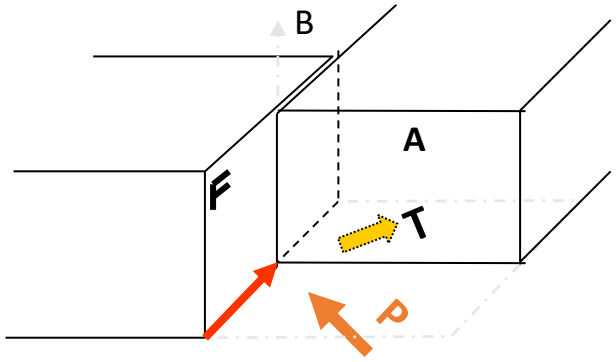
180 90 -90



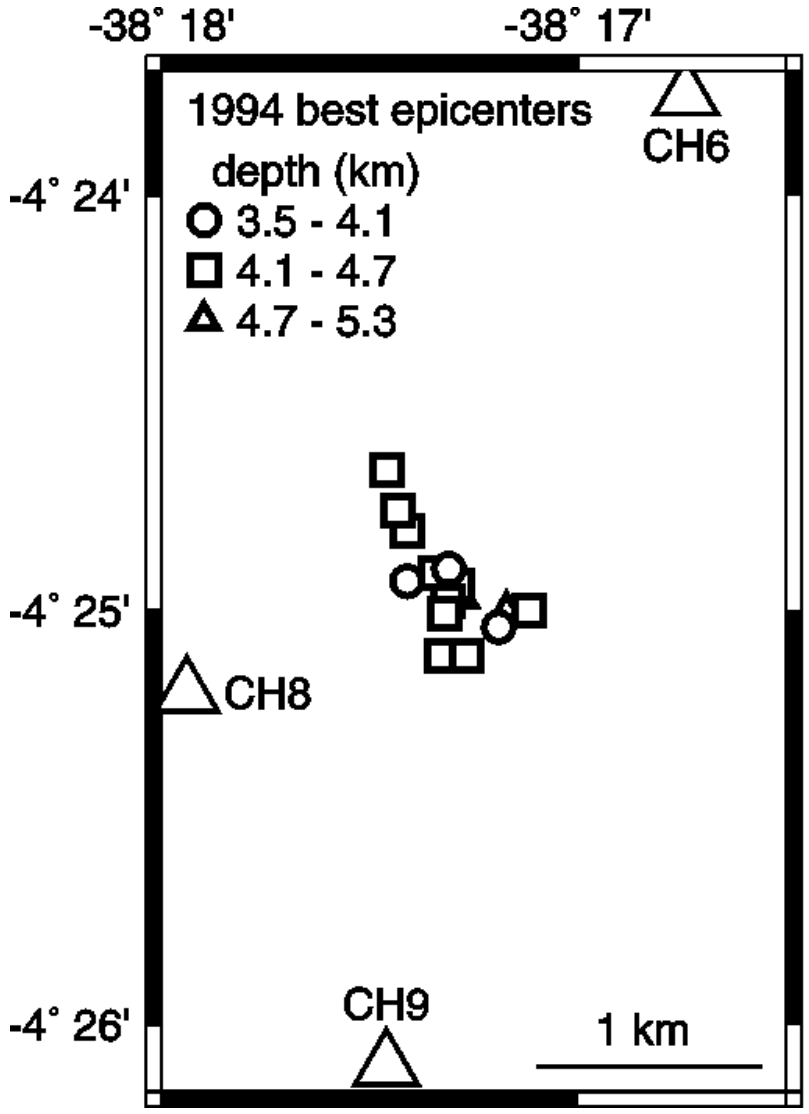
Ejes P y T

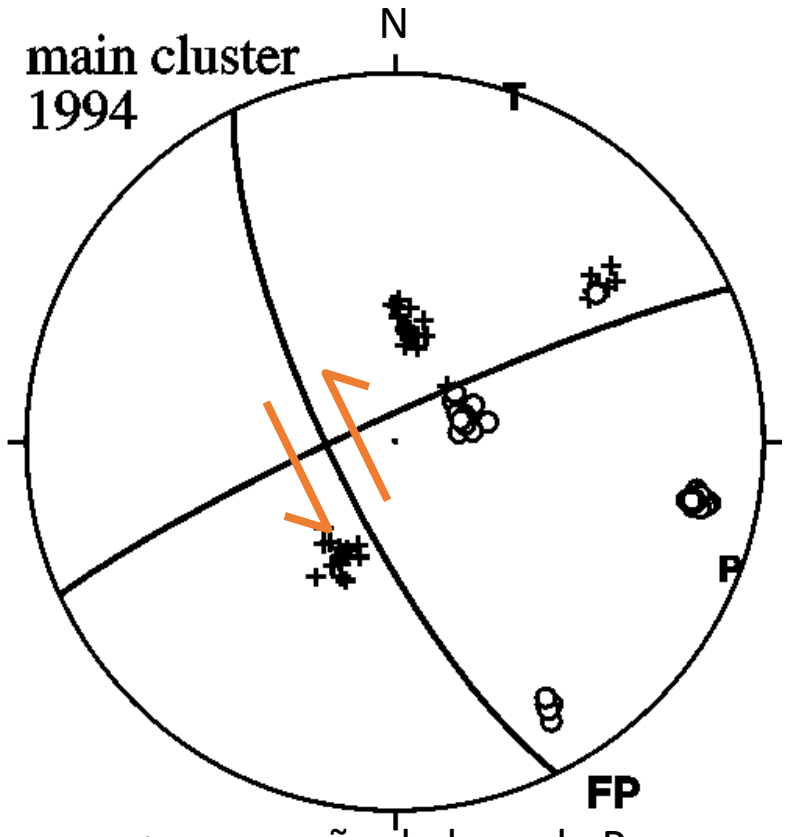
Ejes P y T estan a 45º de los planos F y A, y son perpendiculares al eje nulo (B).

P, T, el polo de F y el polo de A (estría) estan en un mismo plano cuyo polo es B.



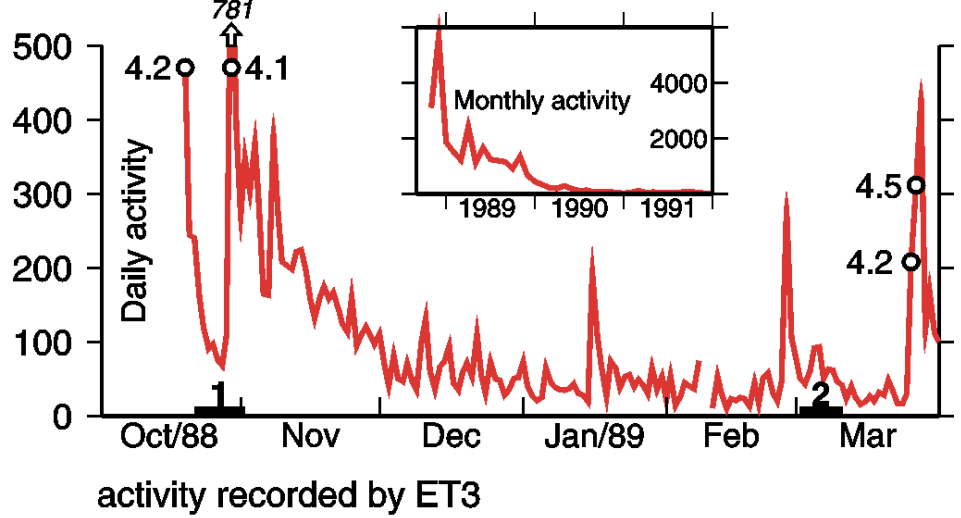
Mecanismo Focal de Chorozinho, NE Brazil, 1994



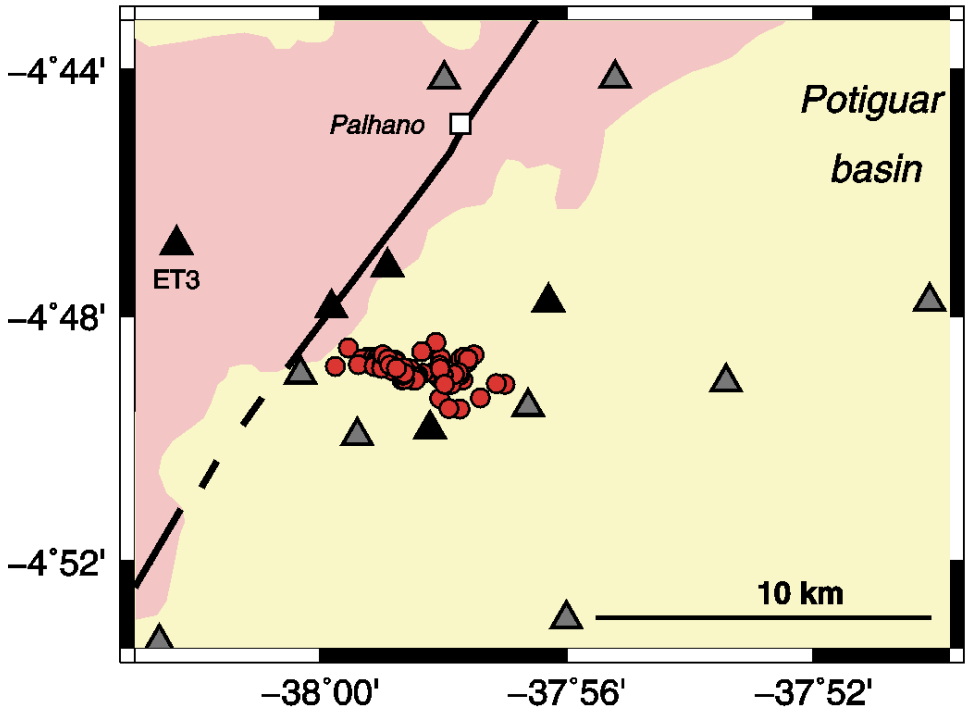


\+ empurrão de la onda P

o puxão de la onda P



activity recorded by ET3

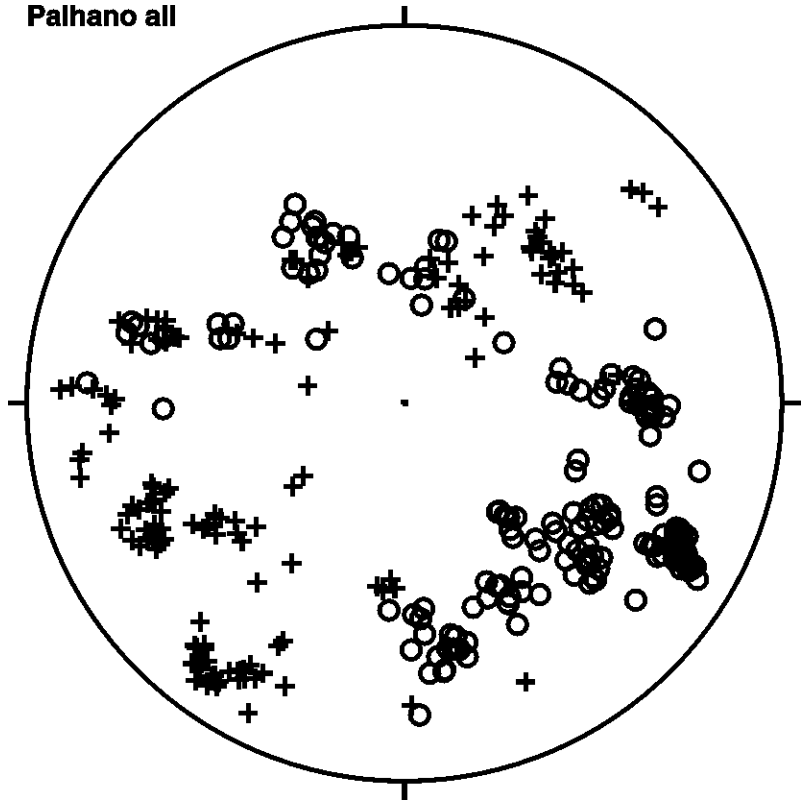


Palhano, CE
field campaign 2, 1989 (Ferreira et al.,1998)

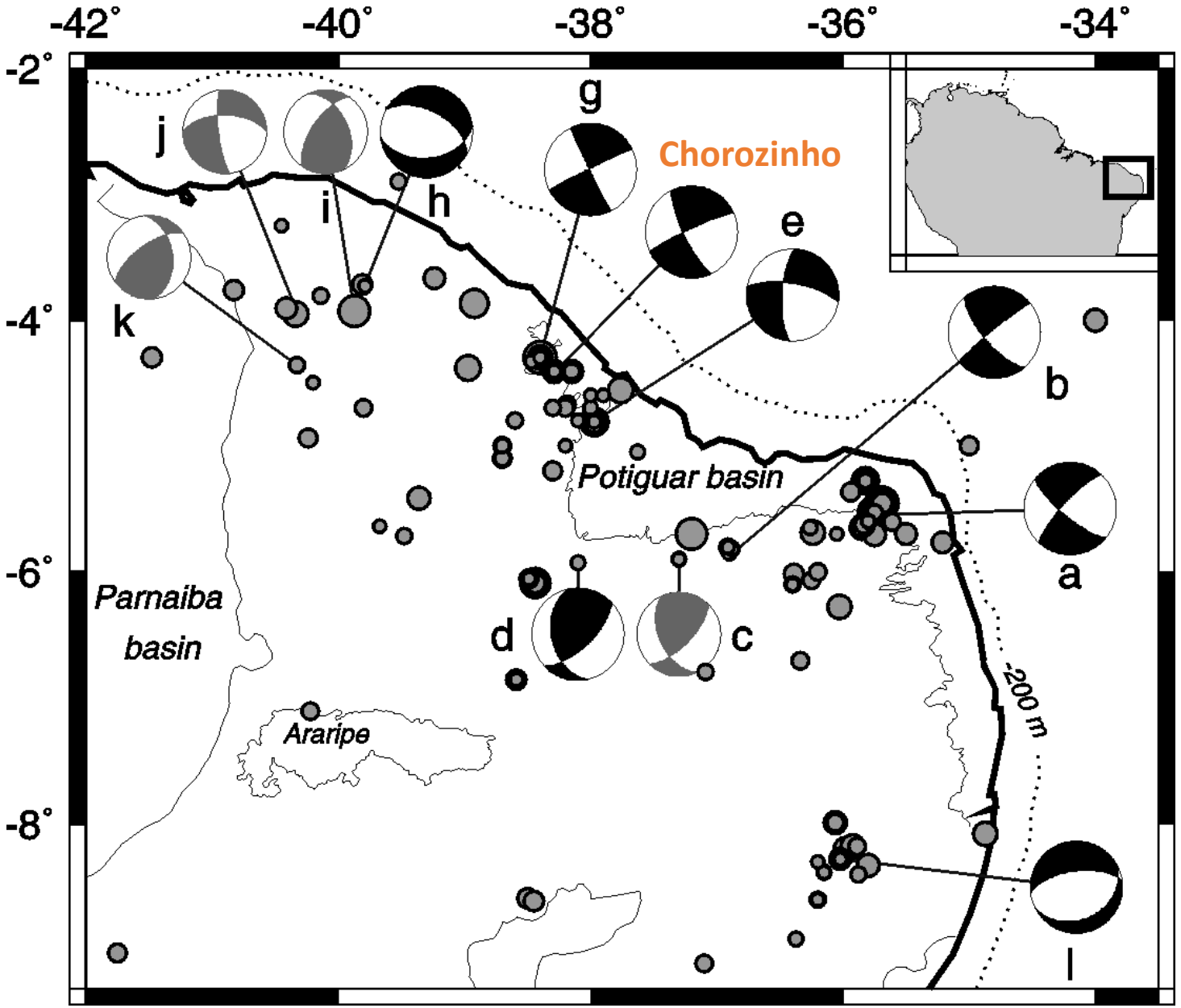
Exercicio 1:

Usar el programa *fps* para determinar el "mecanismo compuesto" para la actividad de Palhano, NE de Brasil.

Estimar
a) el strike, dip y rake de la falla,
b) los ejes P y T
c) el tipo de mecanismo (reverso, normal, transcurrente.

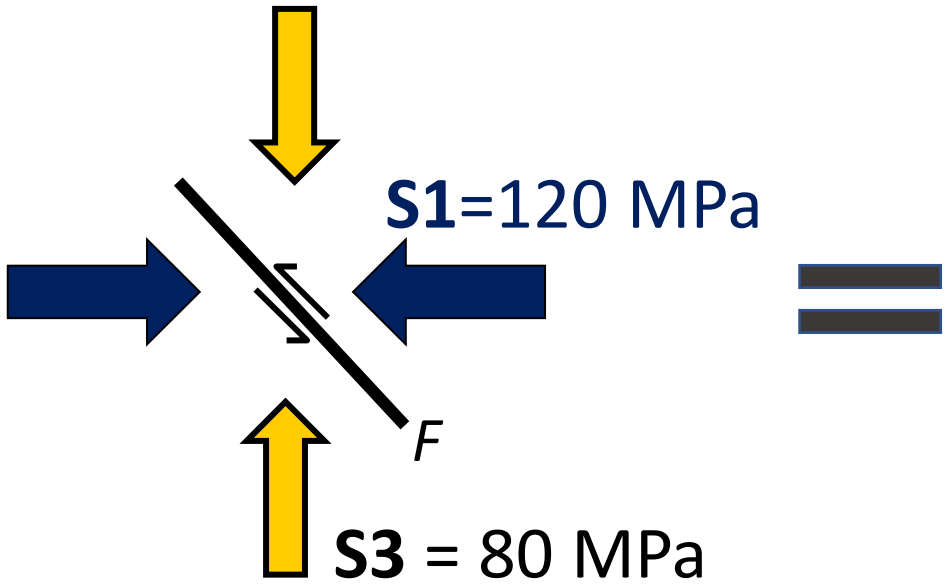


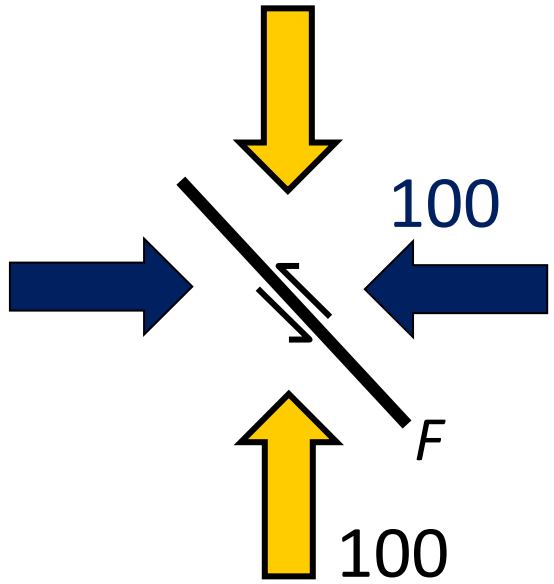
Mecanismos Focales en Nordeste de Brasil

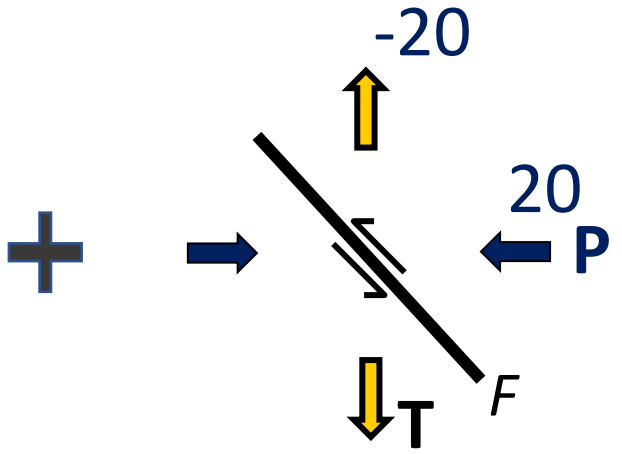


Ferreira et al., (1998)

Eixos **P** (pressão) e **T** (tração) = tensões relativas
Eixos **S1**, **S2**, e **S3** = tensões principais (absolutas)





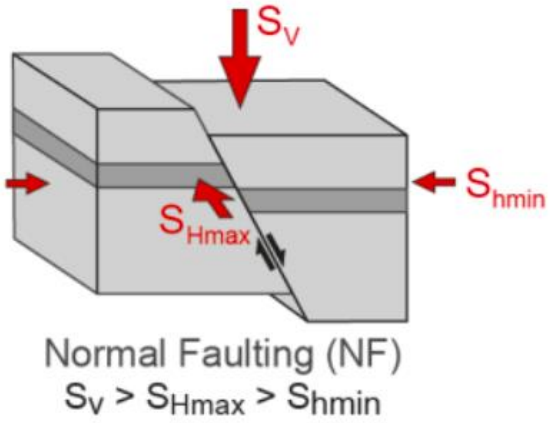


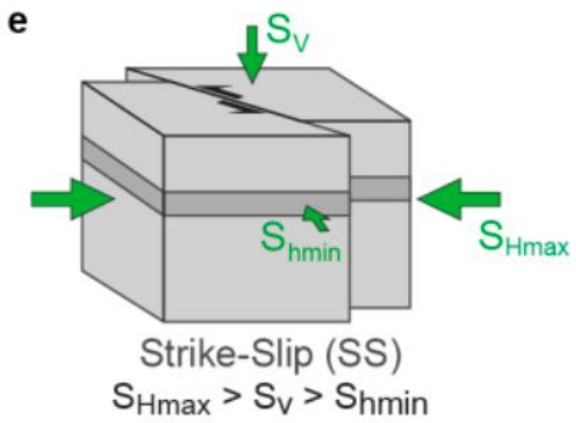
Tensões absolutas

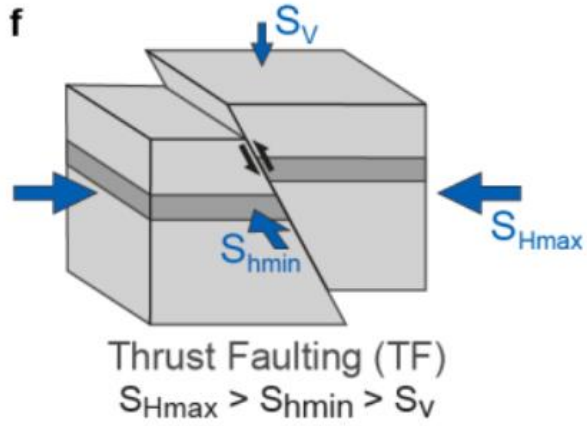
Pressão litostática
$= \rho\, g\, z$

Tensões relativas,
ou desviatóricas

Regimes de Esforço (*Stress Tensor Regime*)
S1 > S2 > S3

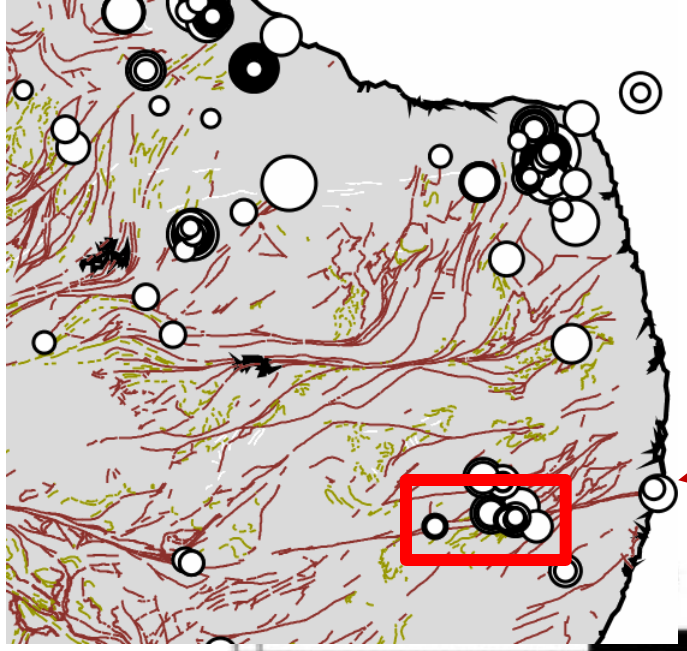




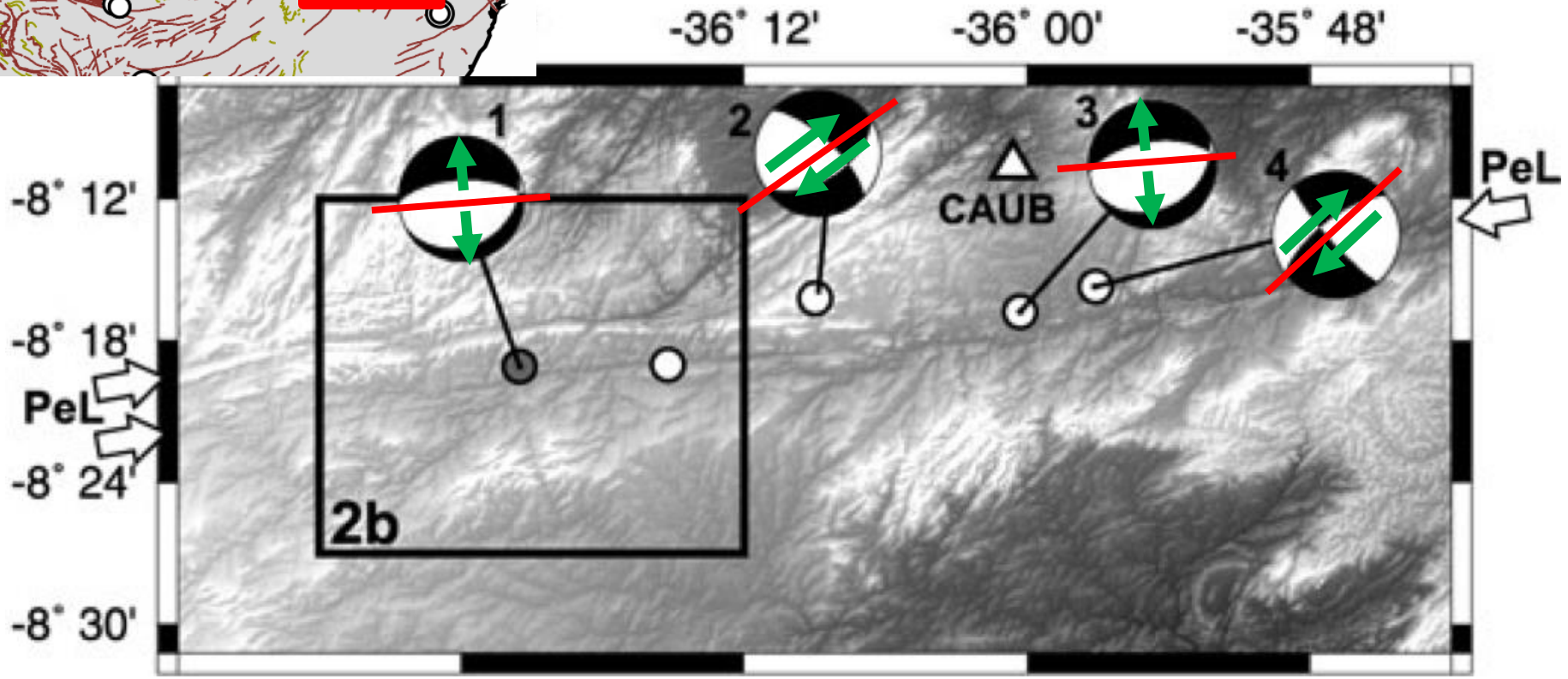


Normal	Transcorrente	Inverso
Sv=S1	Sv=S2	Sv=S3
SHmax = S2	SHmax = S1	SHmax = S1

Sismos no Lineamento de Pernambuco: reativação de estruturas antigas mapeadas na superfície. Exceção em regiões intraplaca !!

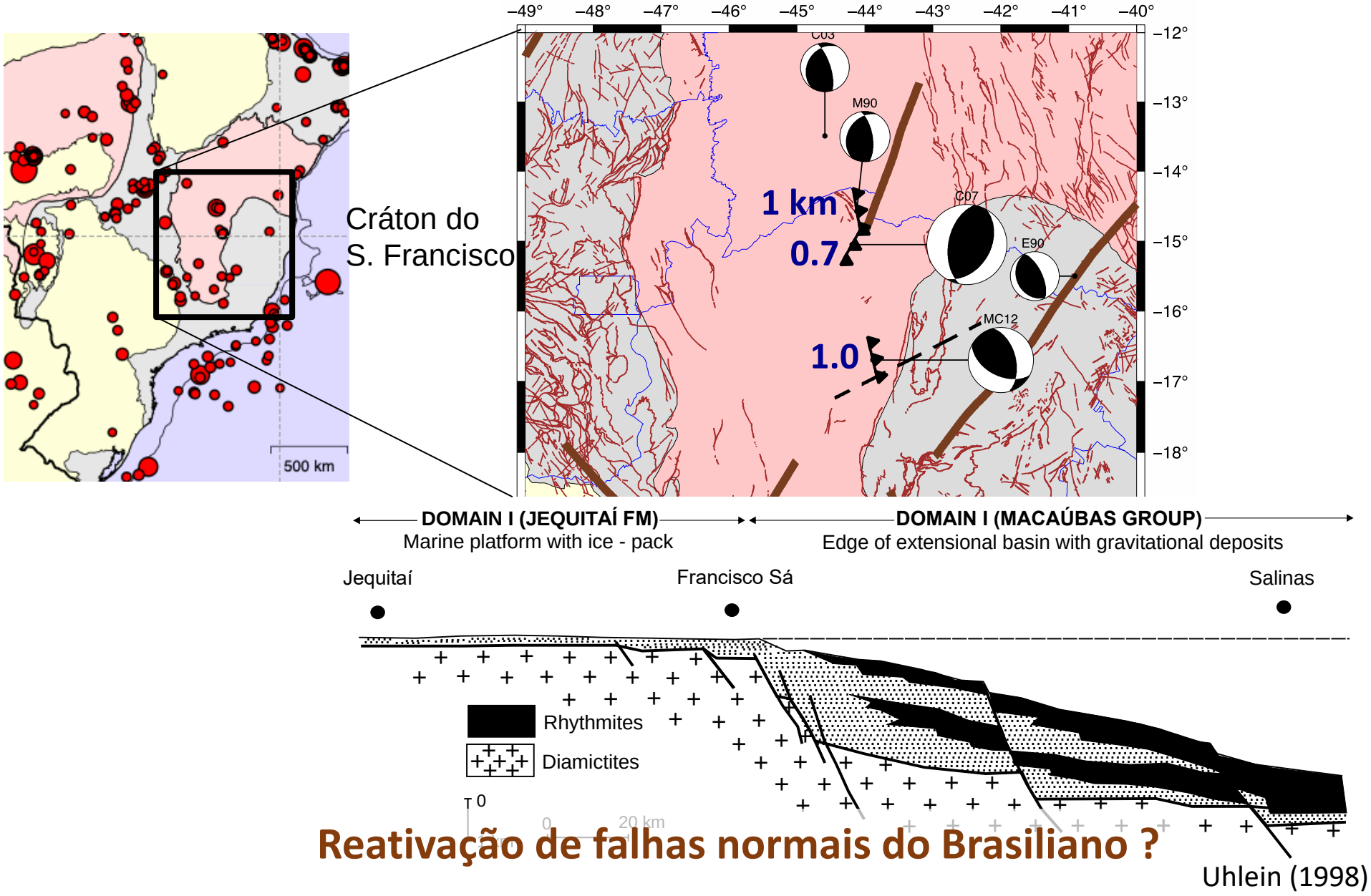


Lin. de Pernambuco



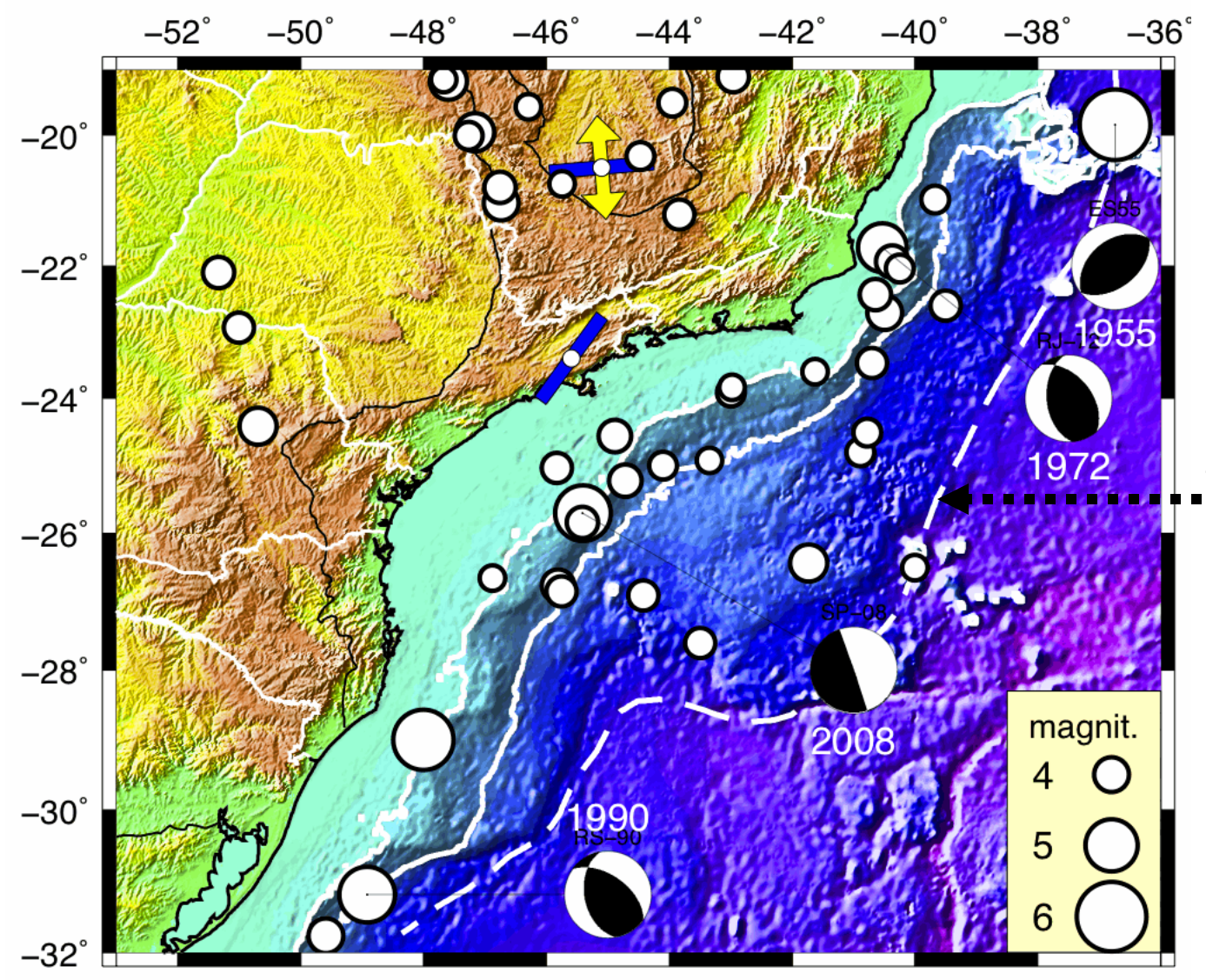
Lopes *et al.*, GJInt, 2010

Predominância de falhas inversas, rasas



Reativação de falhas normais do Brasiliano ?

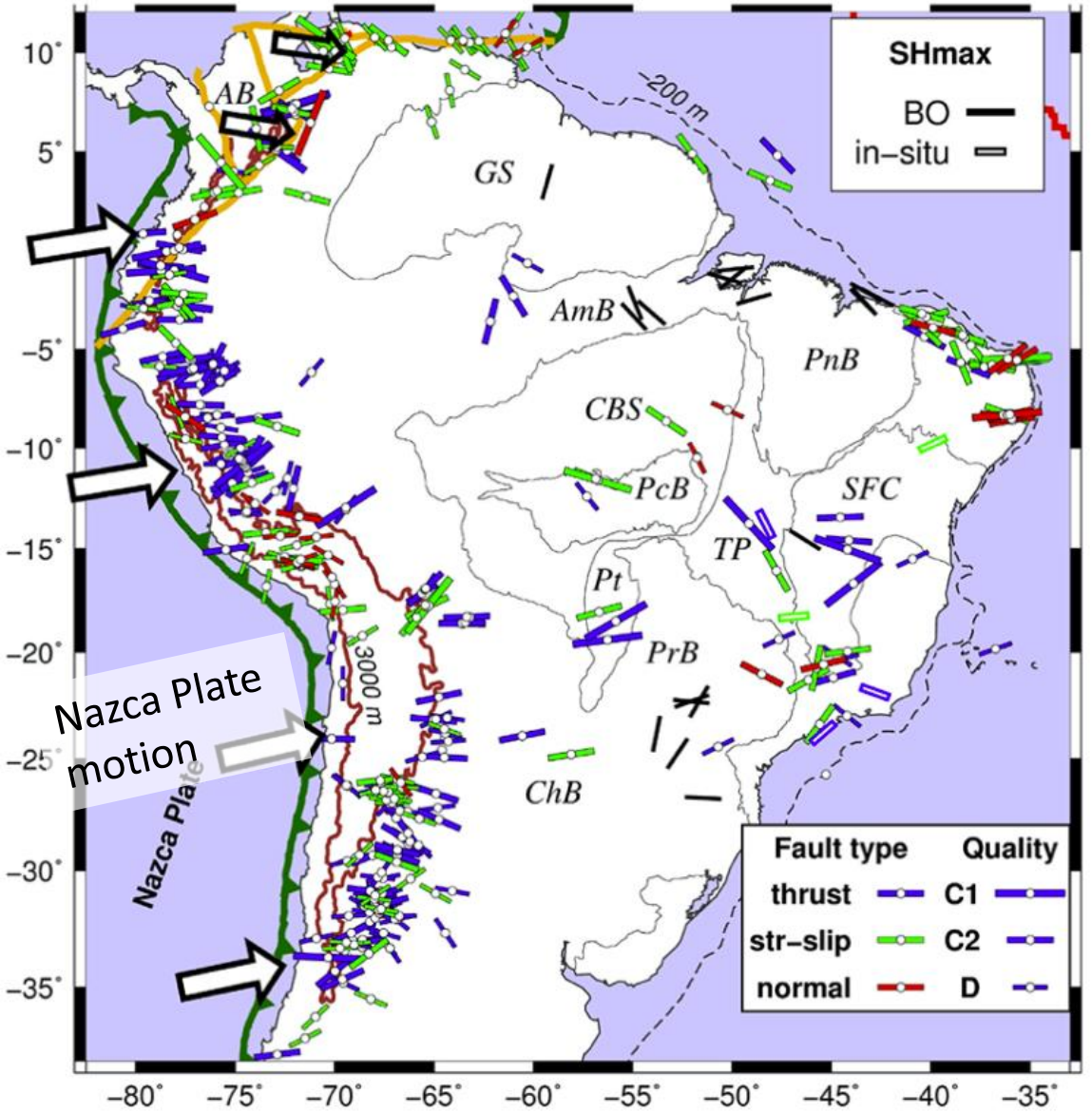
Uhlein (1998)



limite de crosta continental extendida

epicentros, catálogo uniforme

Stress patterns - dados individuais



Average BreakOuts

Hydrofrac + Ovecoring

Assumpção, Dias et al., 2016

Stress patterns - dados individuais

Average BreakOuts

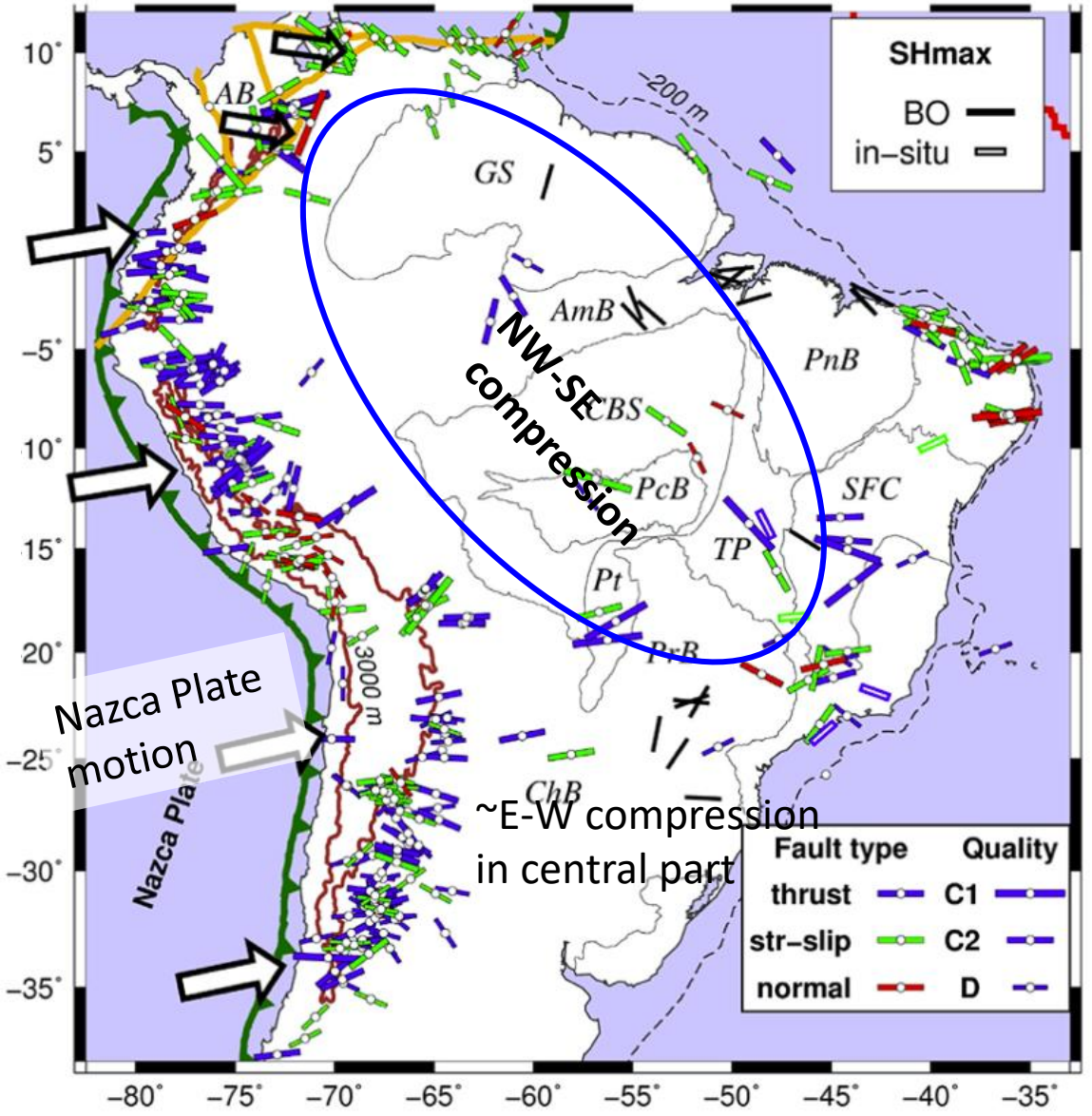
Hydrofrac + Ovecoring

<u>Andean Region:</u>

~E-W compression

Effect of spreading of Andean Plateau

Extension in high Andes



~E-W compression in central part

~ Coast-parallel compression

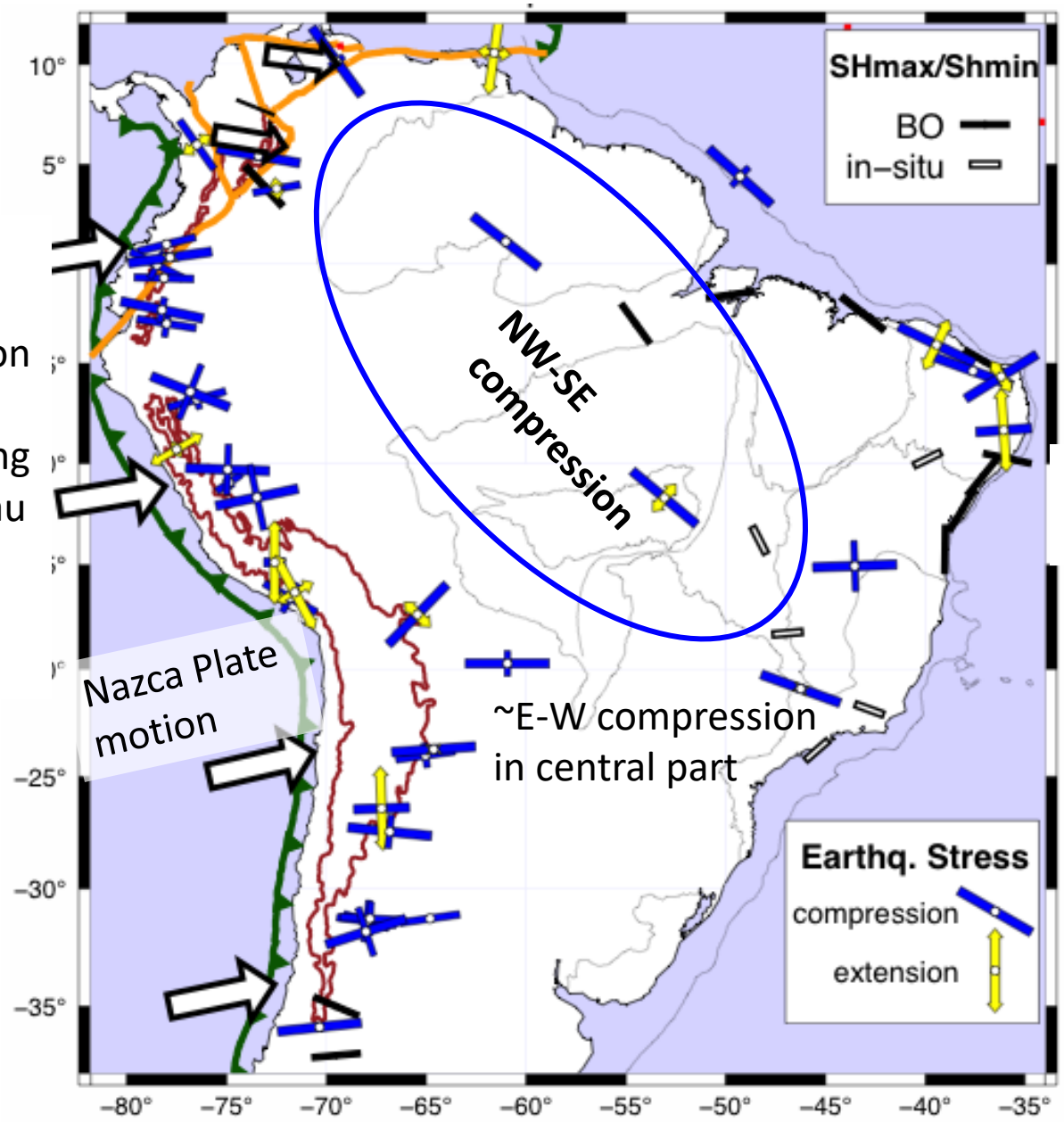
Stress patterns - dados **médios**

<u>Andean Region:</u>

~E-W compression

Effect of spreading of Andean Plateau

Extension in high Andes



Average BreakOuts

Hydrofrac + Ovecoring

~ Coast-parallel compression

Assumpção, Dias et al., 2016