A Synopsis of the Krakatau 1883 Eruption: The Story Told by The Deposits

By

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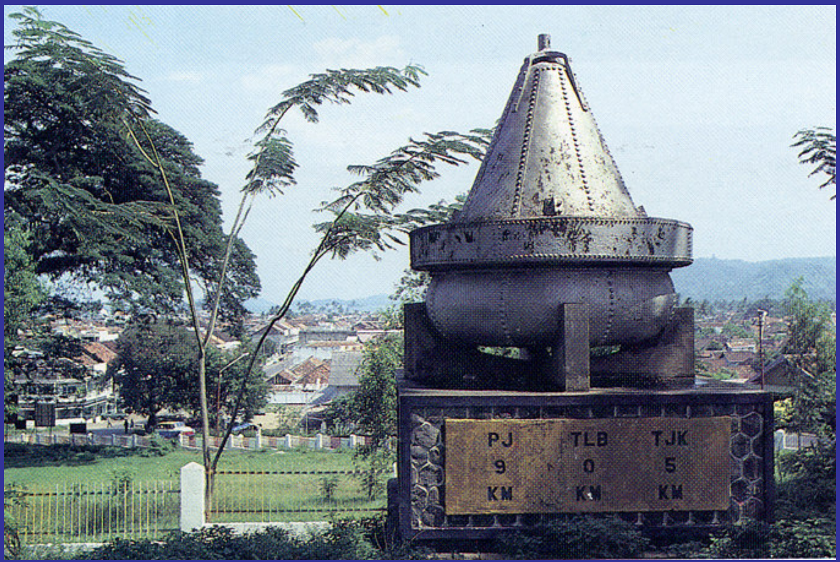
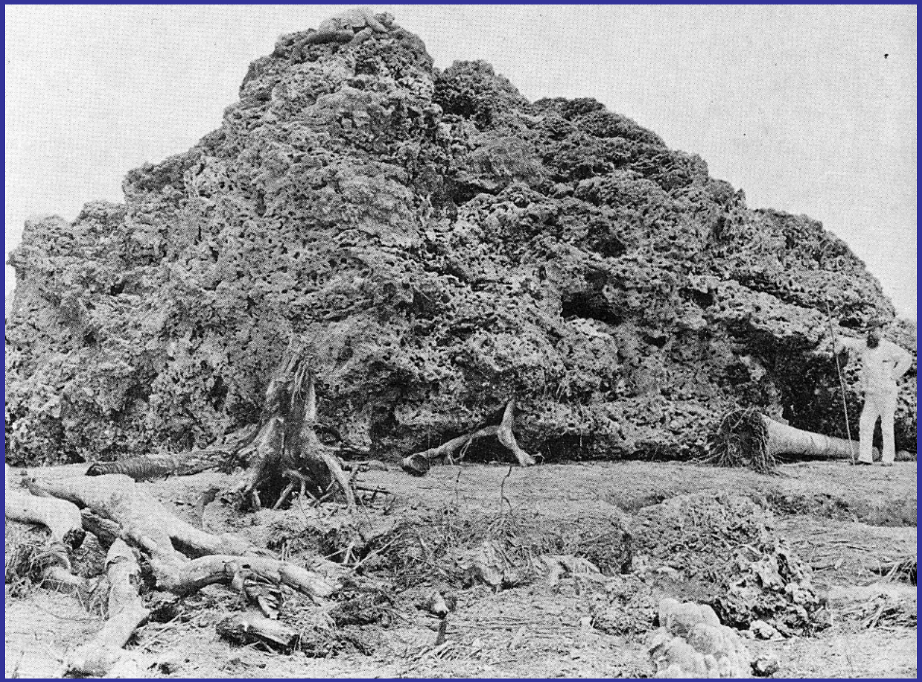
1883 Eruption of Krakatau

- 2nd largest eruption in historical time Aug. 26-27, 1883
- Volcanogenic tsunamis with 15-25 meter height, 40 meter run-up
- 36,000 fatalities, including 1000 burn victims in southern Sumatra
- 14 cubic kilometers of magma erupted in < 24hrs
- 25 km high eruption column

- Berouw Steamship 2.5 km inland, in Koeripan River valley

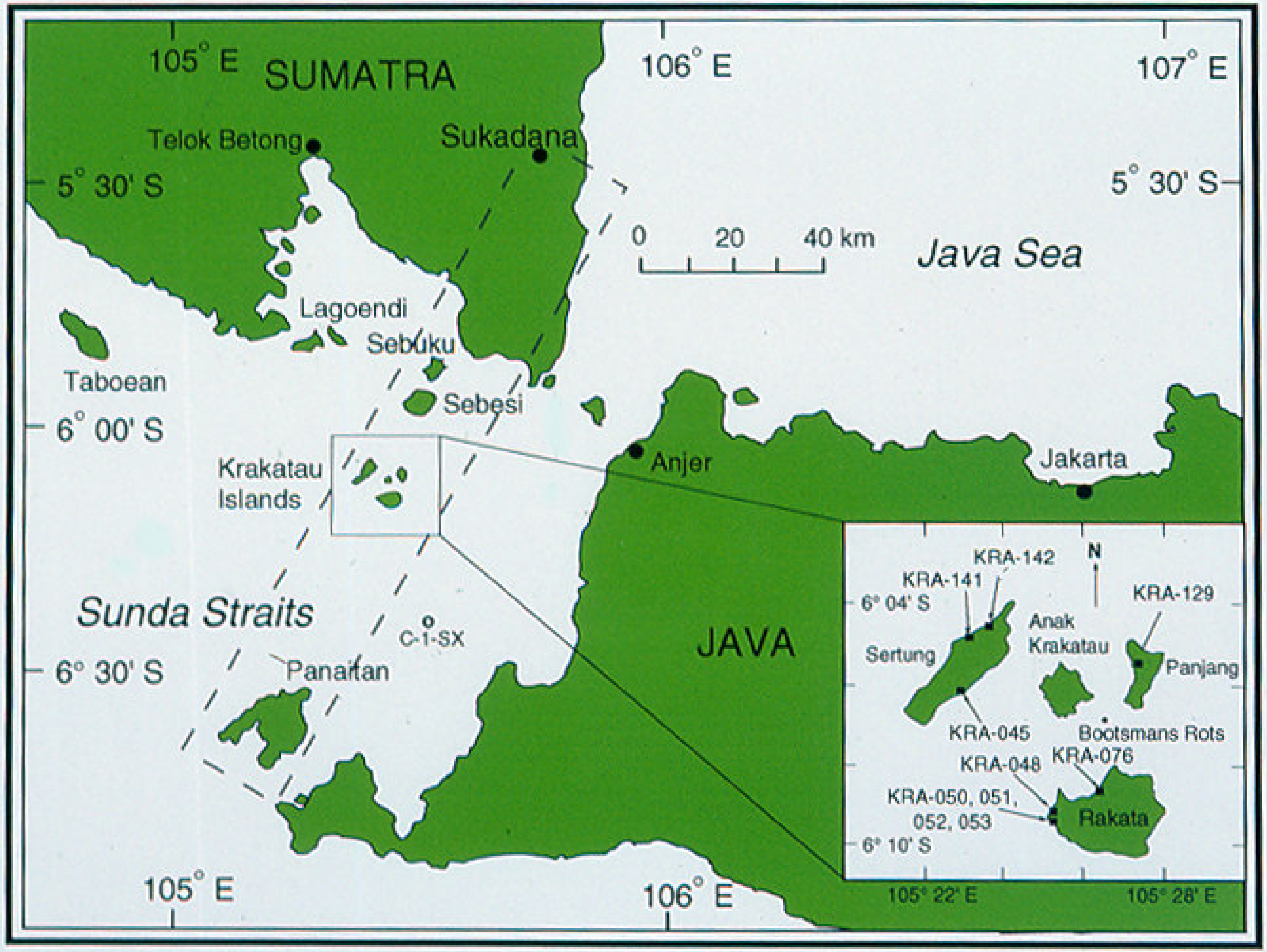


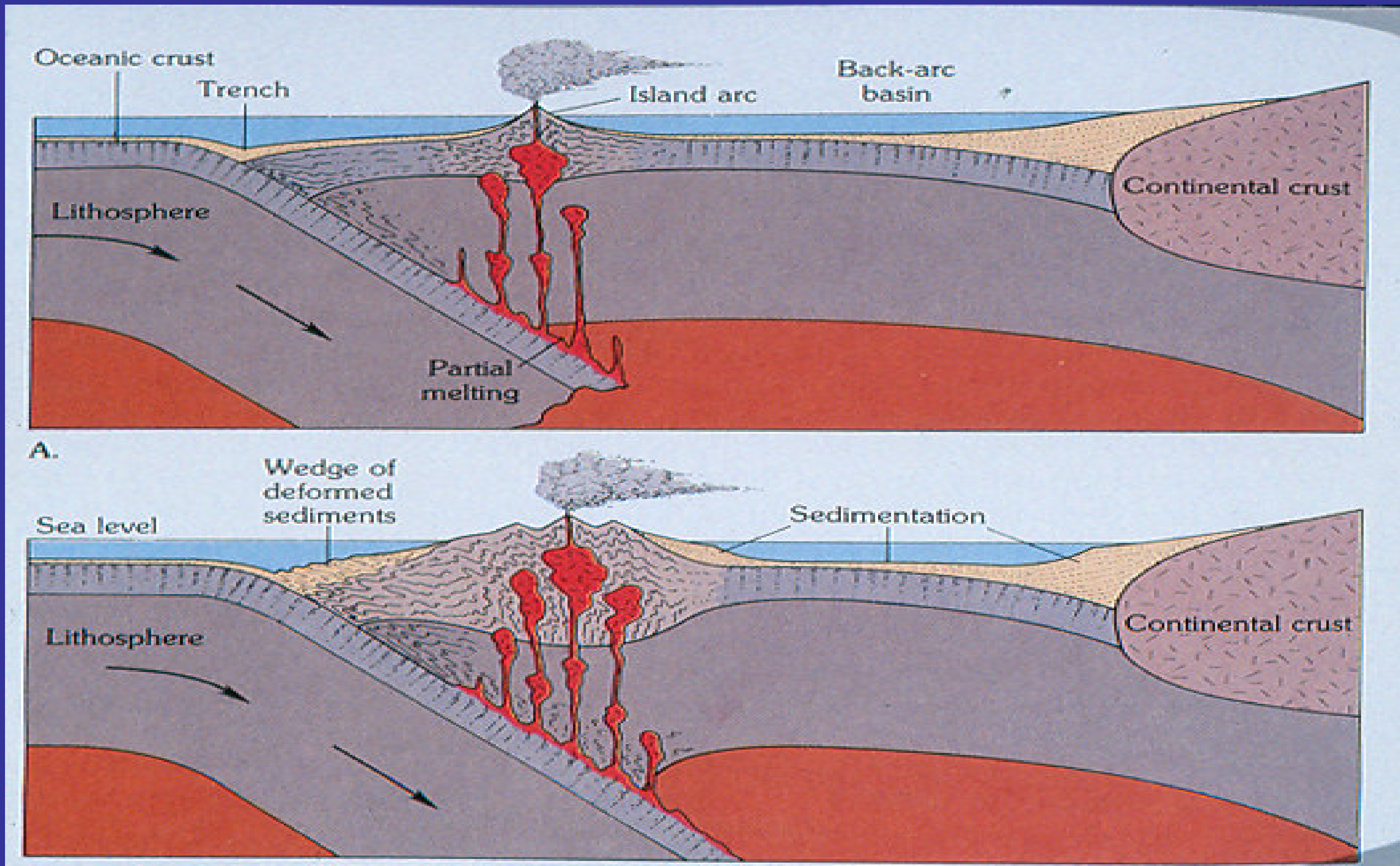
Berouw Mooring Buoy on display today in its final resting place Telok Betung 12 meters above sea level



- 600 ton coral block washed ashore at Anjer, Lighthouse destroyed

Locomotive destroyed at Merak, rails bent like ribbons

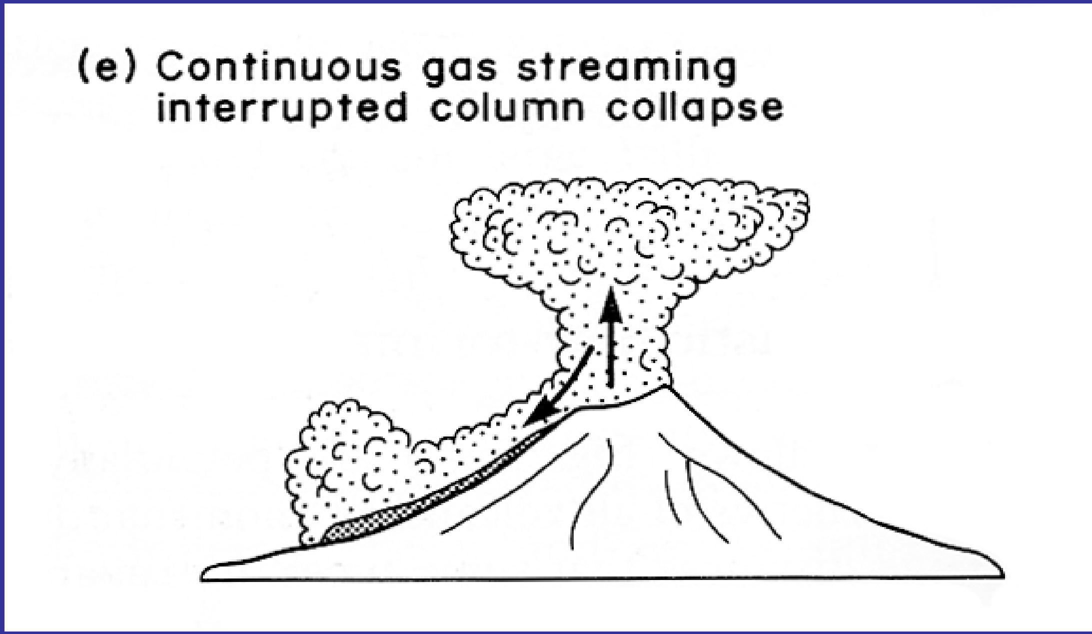

105° E
SUMATRA
106° E
107° E
Telok Betong
Sukadana
5° 30' S
5° 30' S
0
20
40 km
Java Sea
Lagoendi
Sebuku
Taboean
Sebesi
6° 00' S
Krakatau
Islands
Anjer
Jakarta
Sunda Straits
C-1-SX
JAVA
6° 30' S
Panaitan
105° E
106° E
KRA-142
KRA-141
6° 04' S
N
KRA-129
Sertung
Anak
Krakatau
Panjang
KRA-045
Bootsmans Rots
KRA-048
KRA-076
KRA-050, 051,
052, 053
Rakata
6° 10' S
105° 22' E
105° 28' E

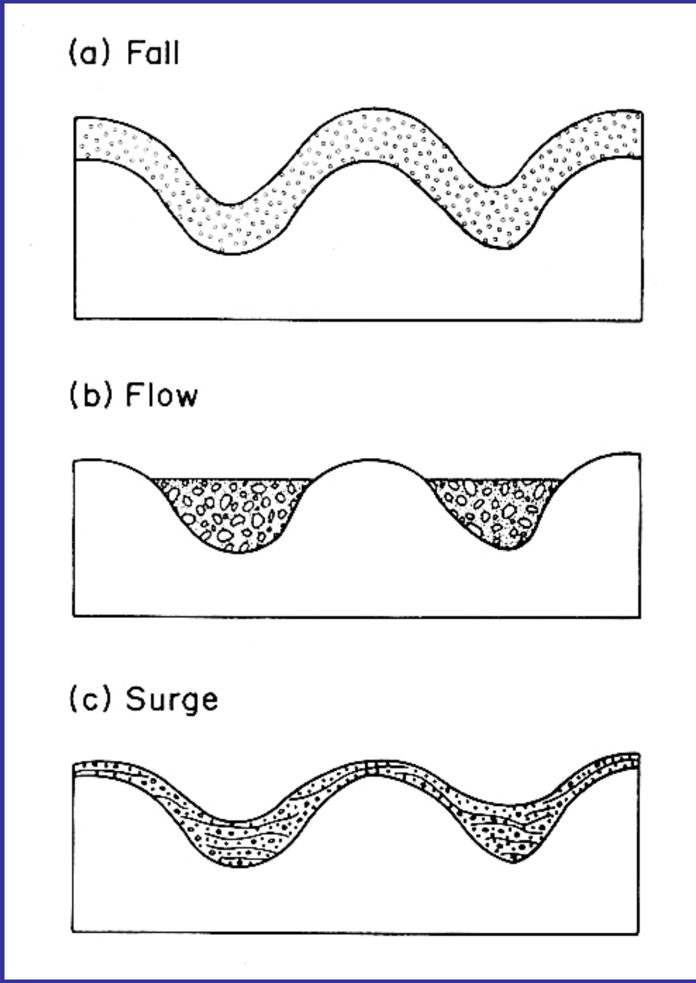

Oceanic crust
Trench
Island arc
Back-arc basin
Continental crust
Lithosphere
Partial melting
A.
Wedge of deformed sediments
Sea level
Sedimentation
Continental crust
Lithosphere

1990 fieldwork on Krakatau islands

- Study of land based deposits on all islands
- Develop general stratigraphic sequence multiple locations
- Estimate height of eruptive plume from clast dispersal
- Collect bulk samples for laboratory grain size and component analysis and geochemical analysis

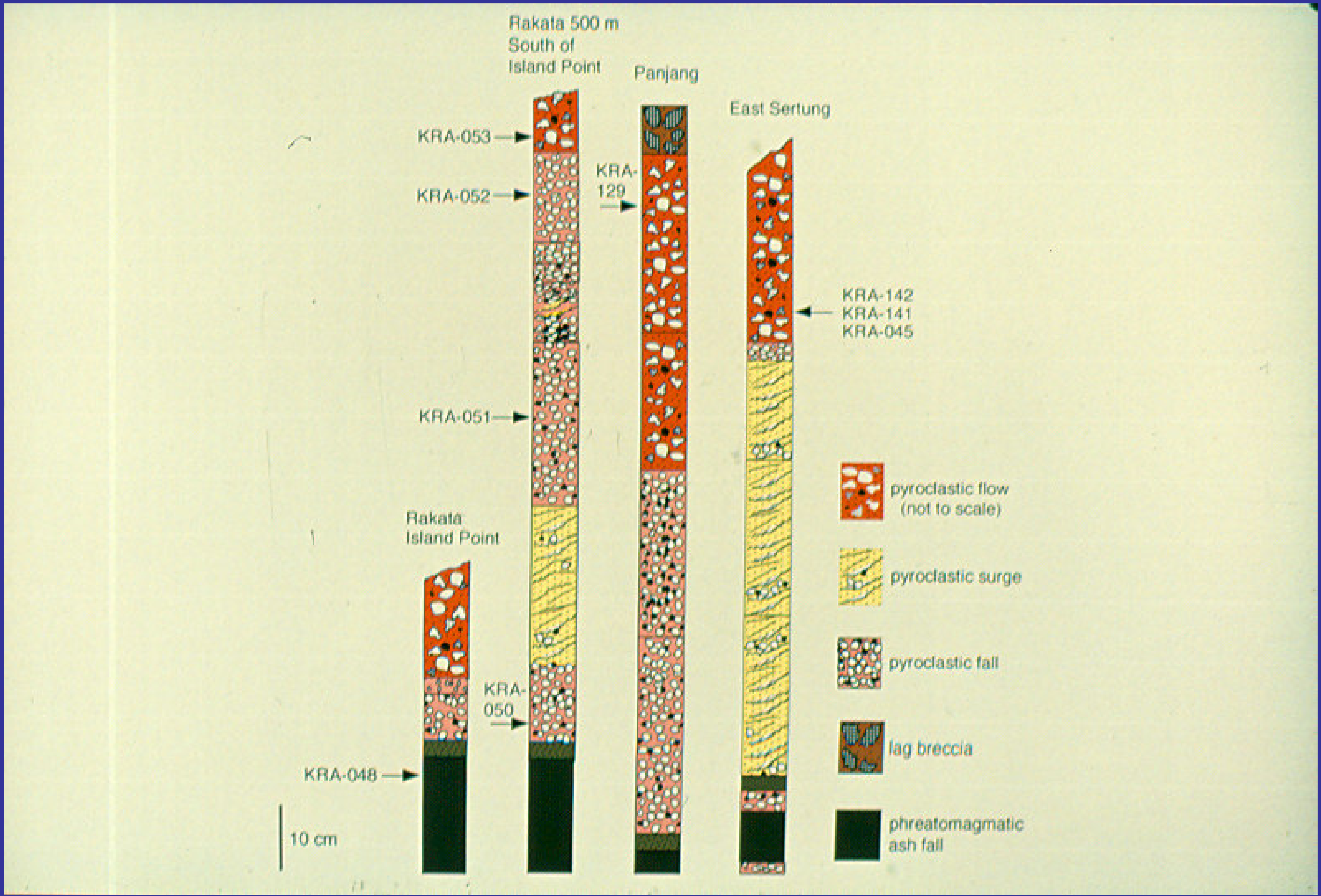
Types of pyroclastic deposits





- Each deposit type tells us something about the eruption process

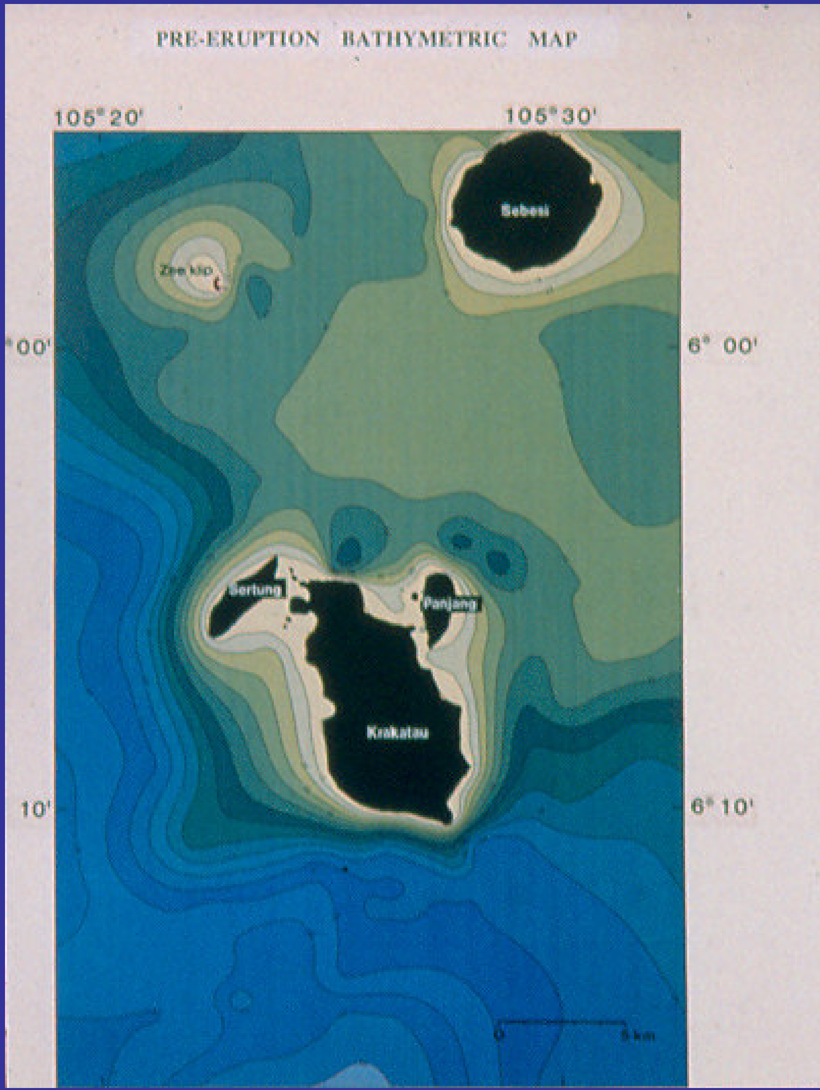
Land based stratigraphy



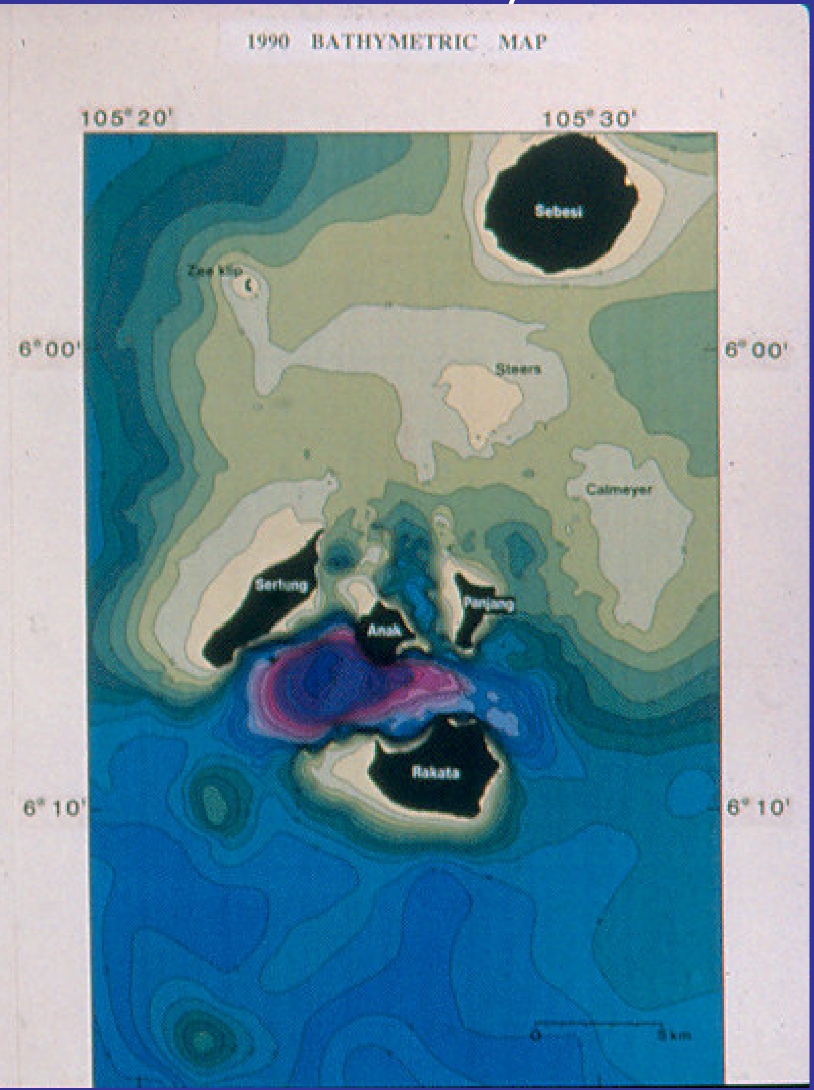
Marine based work around Krakatau

- New bathymetry needed for SCUBA core dives
- New bathymetry need to determine volume of 1883 deposits eroded
- Recovery of the first submarine samples in 107 years!
- Grain size and component analysis and paleomagnetic analysis

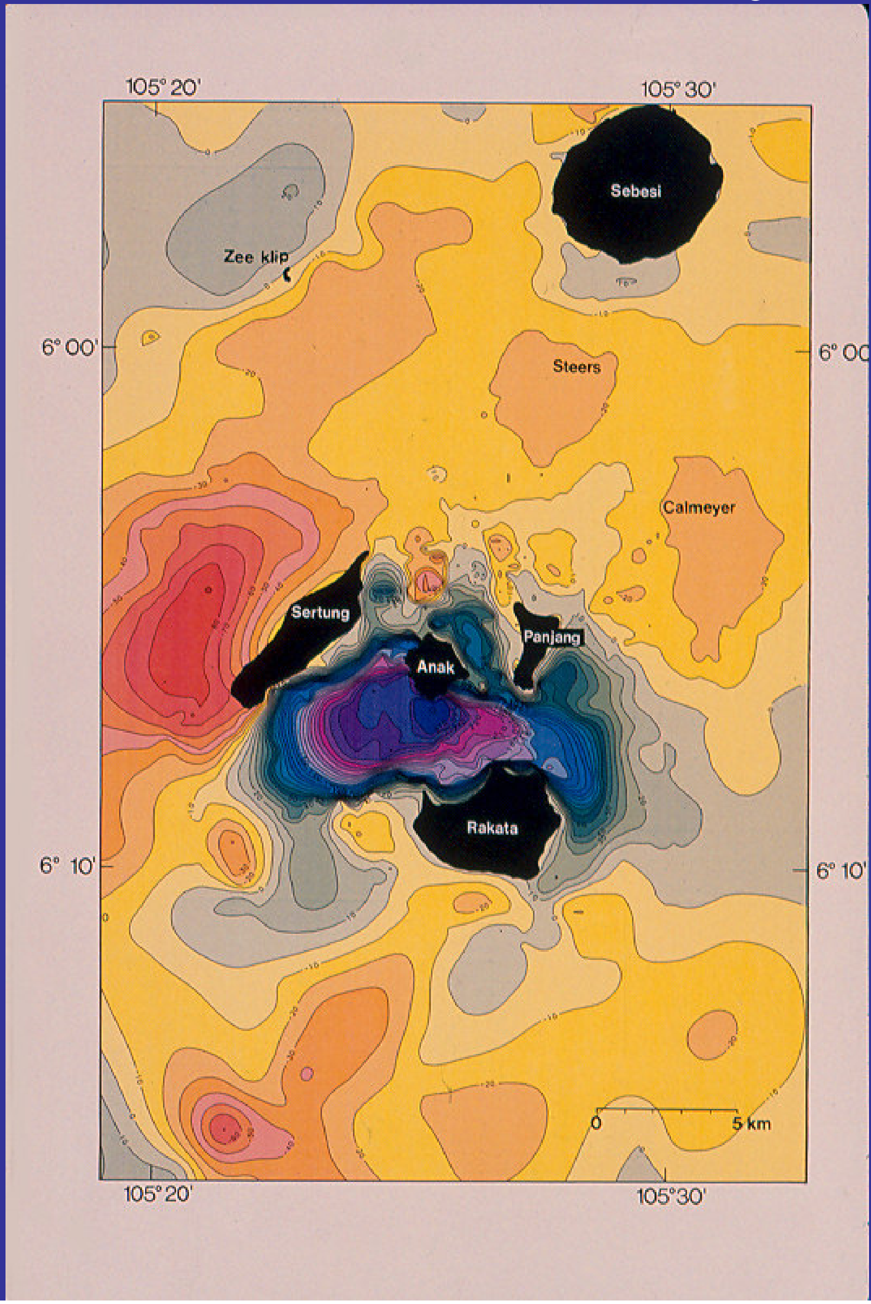
Pre-1883



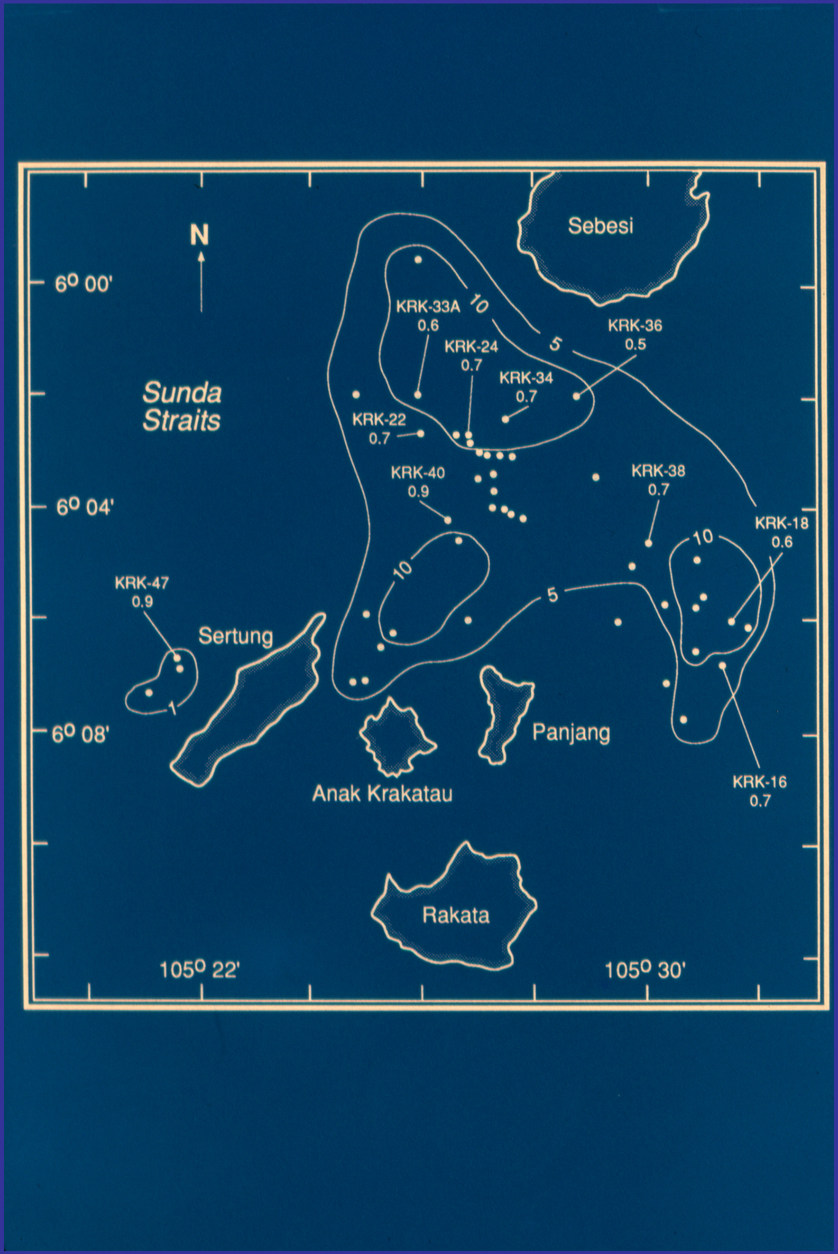
Today



1990 Bathymetry reveals

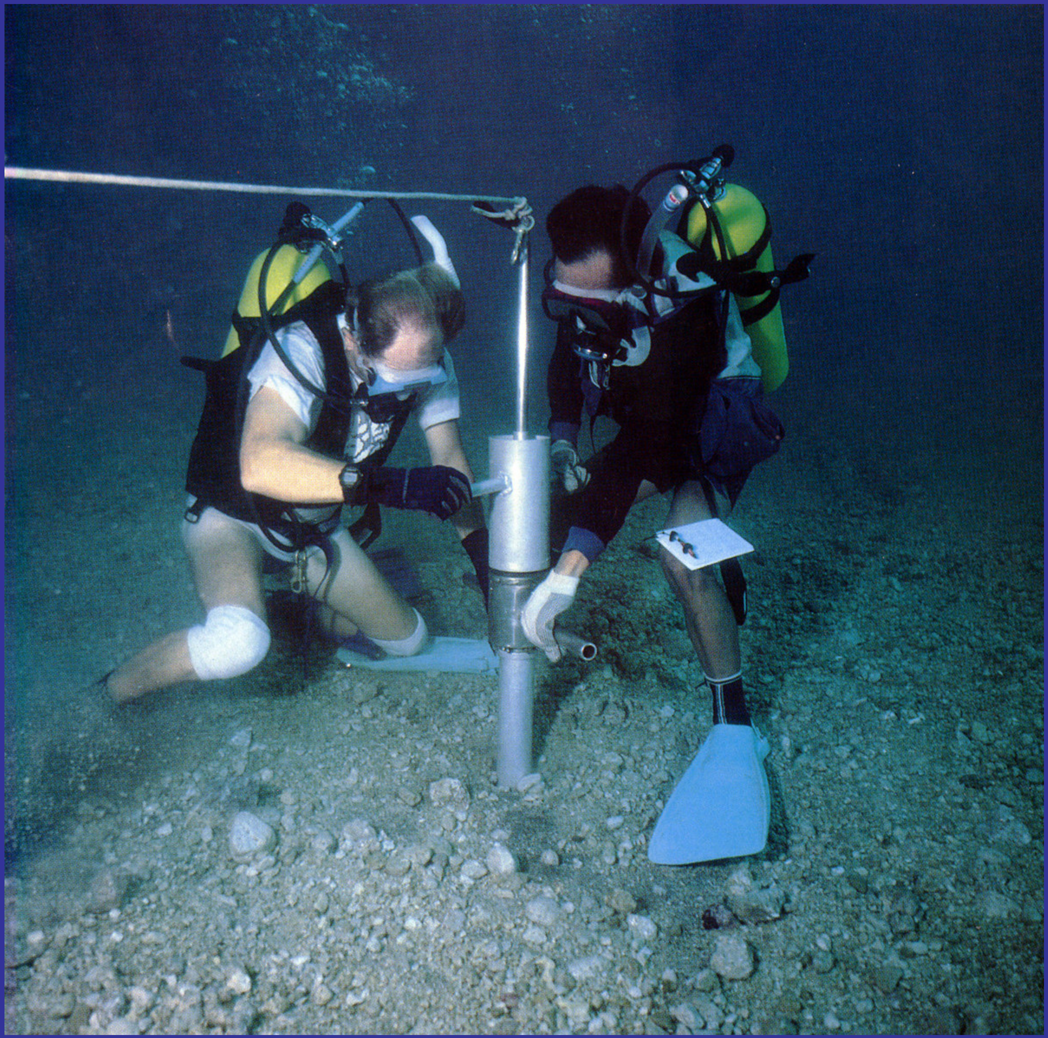


- 78% of erupted tephra deposited on the seafloor surrounding the volcano
- Formation of 270 meter deep caldera
- Formation of two ephemeral islands Steers and Calmeyer
- Accumulations up to 90 meters thick west of Sertung
- Accumulations up to 60 meters thick to southwest



- 0.4 cubic kilometers of erosion into 1883 deposits
- SCUBA core sites occur 1-20 meters below original deposit surface
- Allows us to see the interior of 1883 submarine deposits

SCUBA Core Recovery



59 SCUBA cores recovered (~1.5 meters)

At many dive locations 1883 deposits are 10-20 cm below reworked sediments

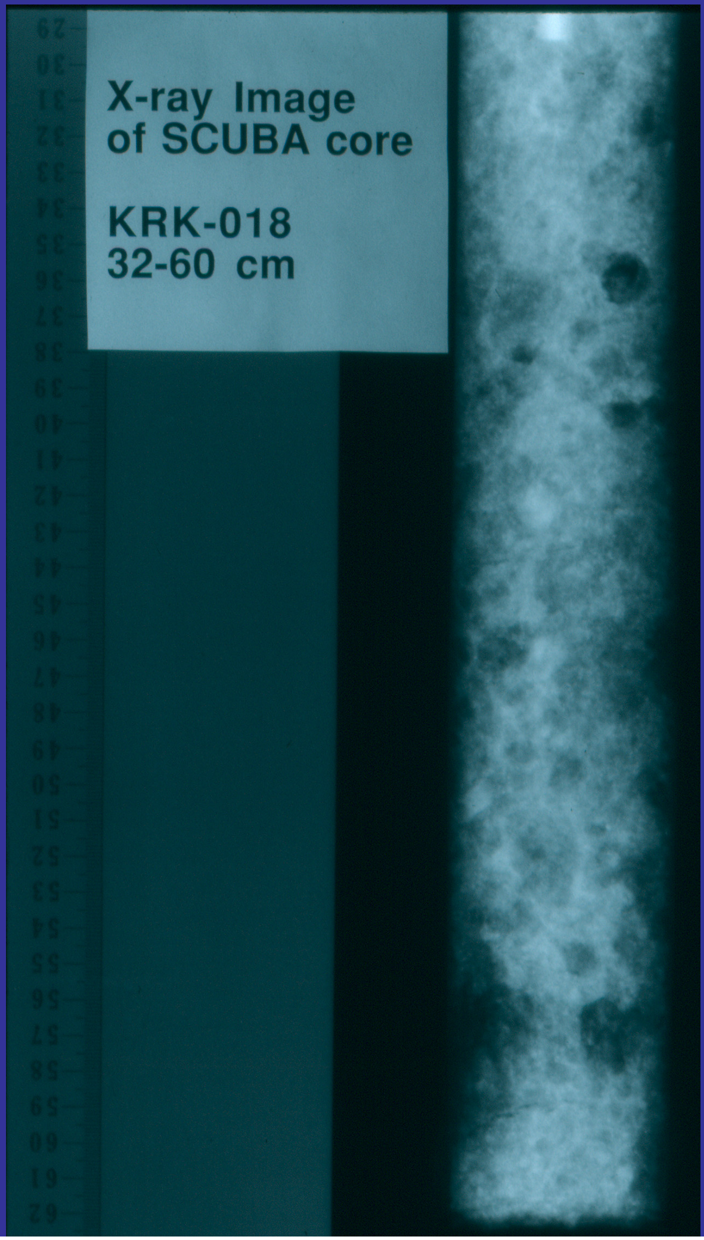
Massive textured material most common

Laminated fine-grained material less common

SCUBA Core sample

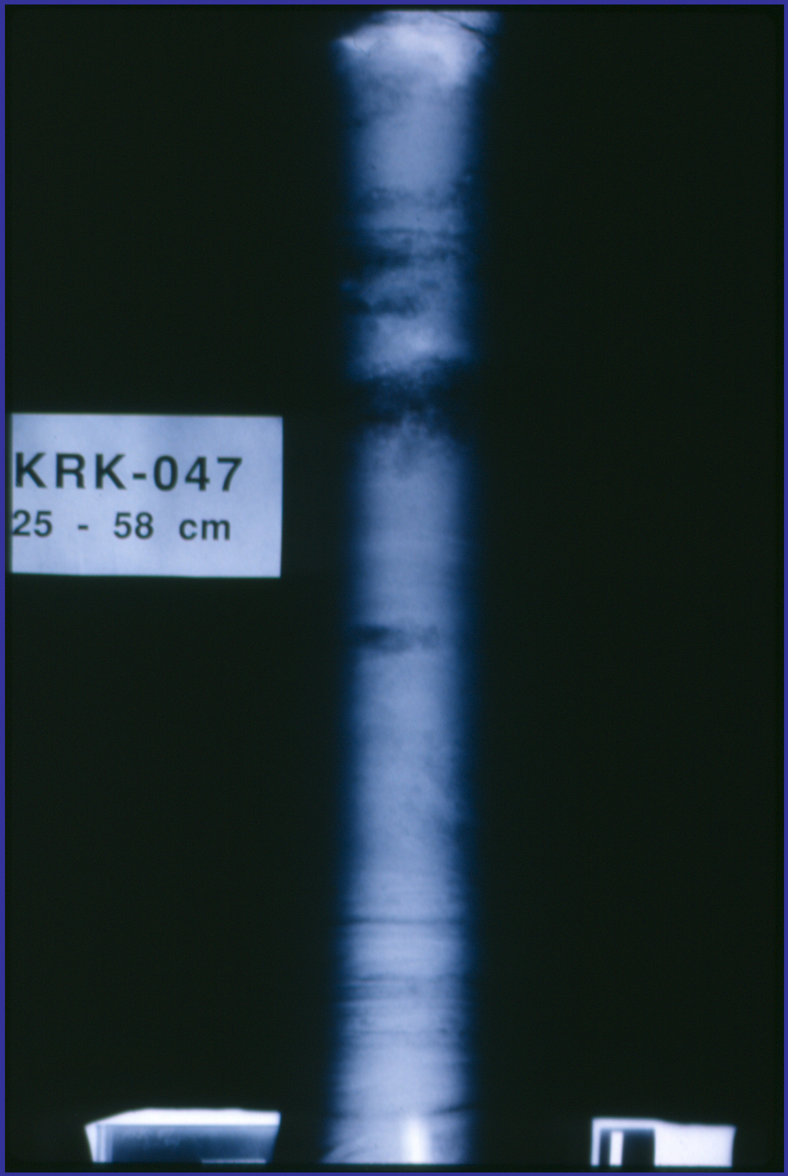
- Massive textured material is poorly sorted
- Retains 27-48% fine ash matrix (<125 microns)
- Density of grains ranges from ~ 1.0 to 5.1g/cm^3
- Paleomagnetic study indicates emplacement on sea floor at temperatures > 475°C

X-ray radiograph of SCUBA Core KRK-018



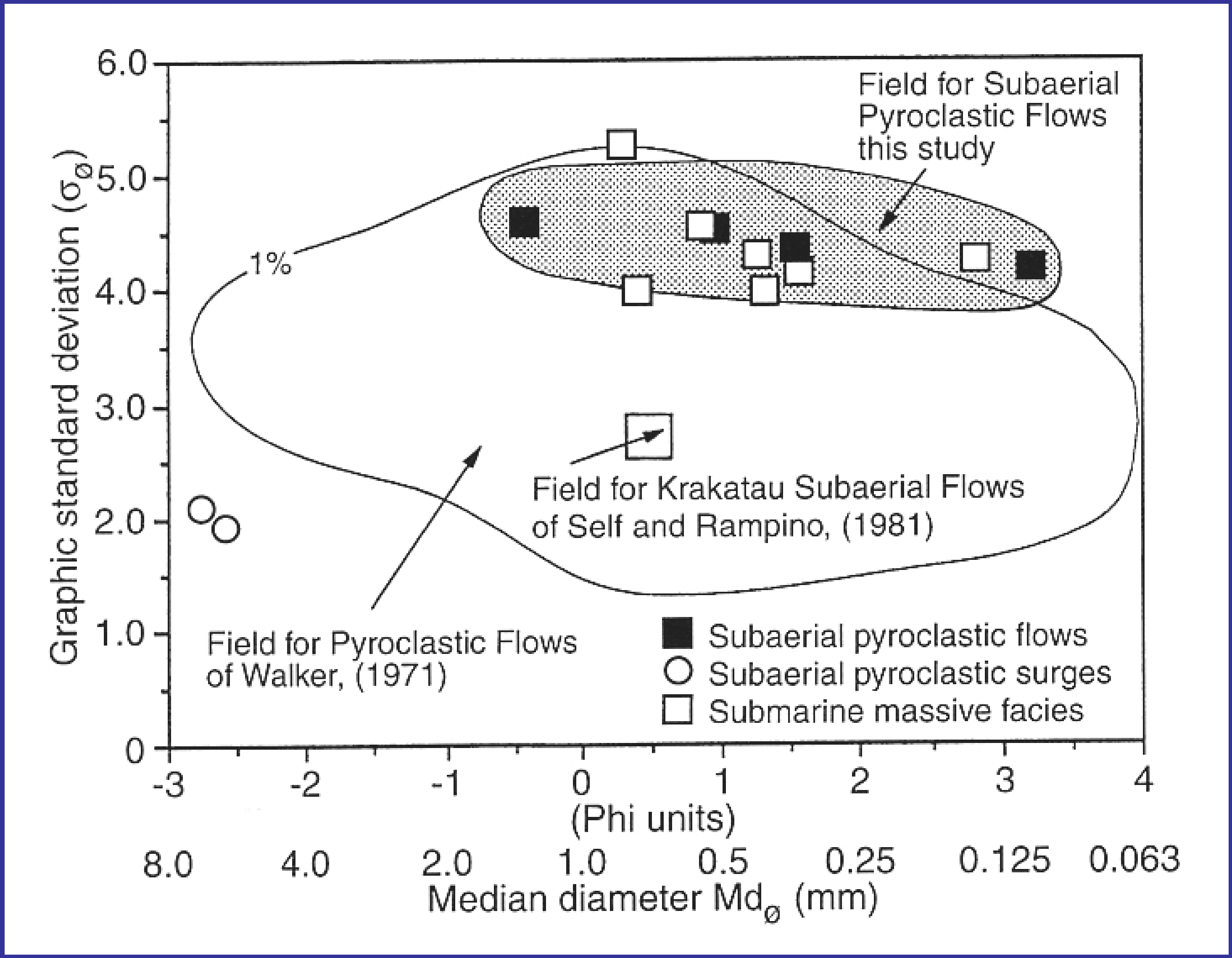
- Low density pumices appear dark
- High density rock fragments appear bright

SCUBA Core KRK-047



- Laminated material is well sorted
- Glass enriched
- Poor in crystals and rock fragments
- Texture and component abundances suggest extensive hydraulic sorting

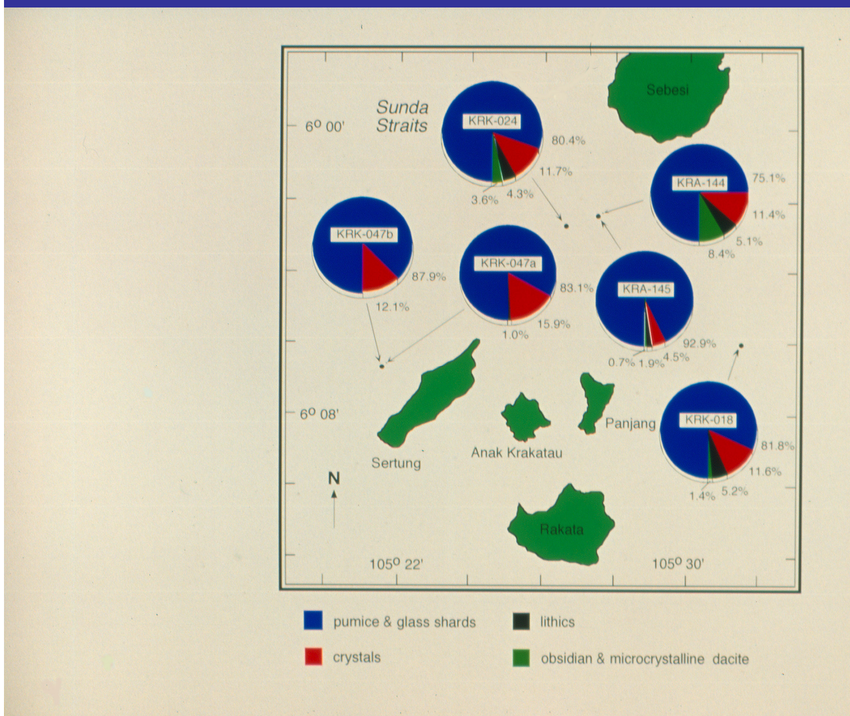
Grain size and sorting comparison

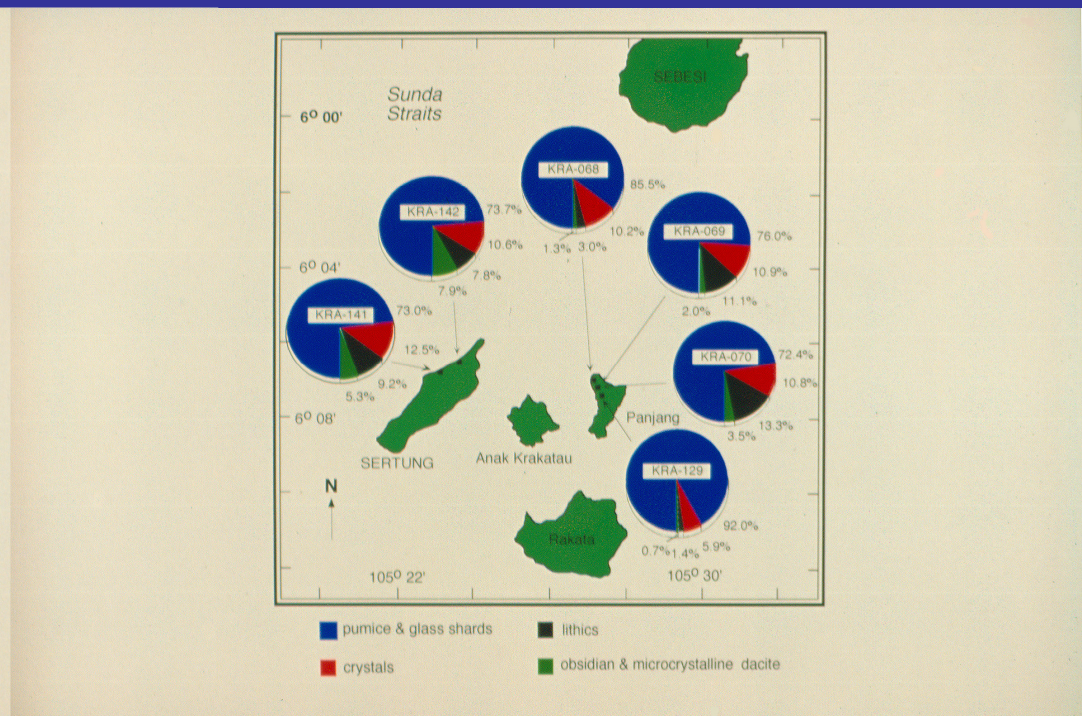


Marine massive textured and pyroclastic flows indistinguishable

Submarine Massive Samples

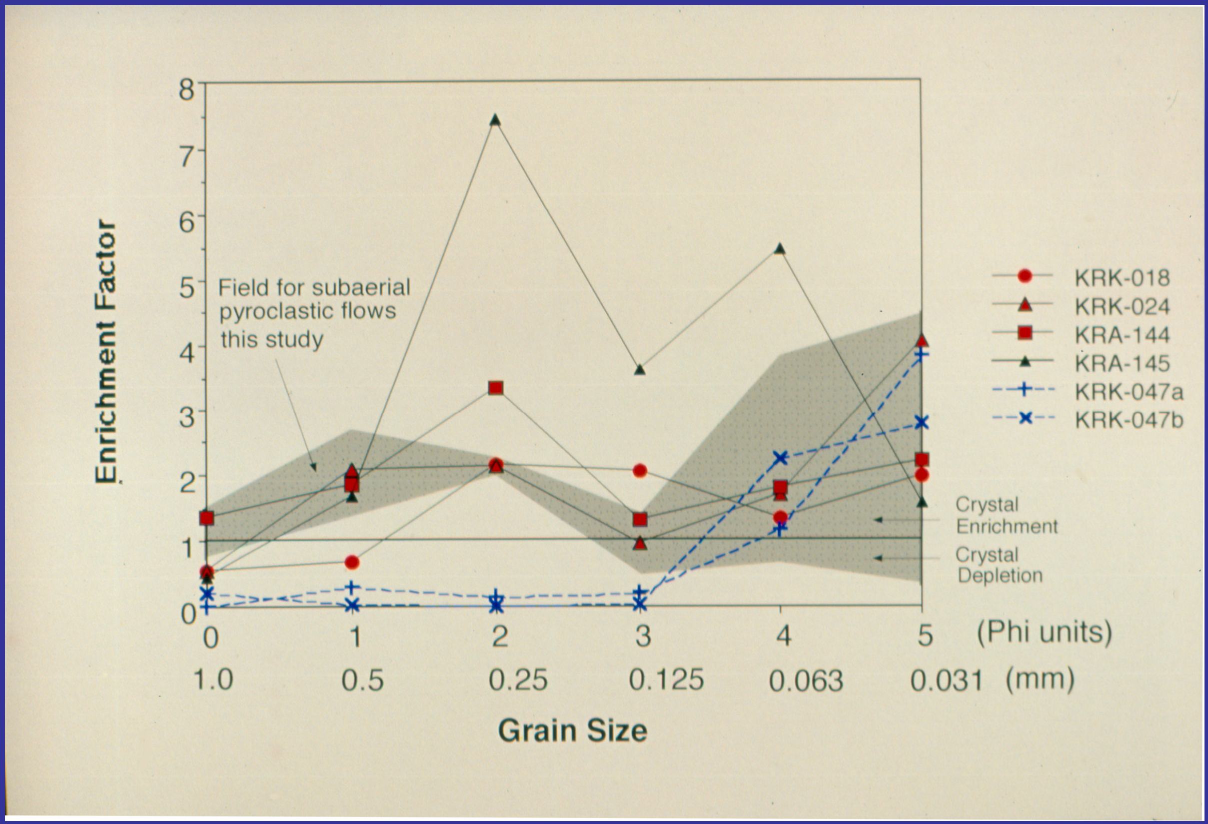
Pyroclastic Flow Samples





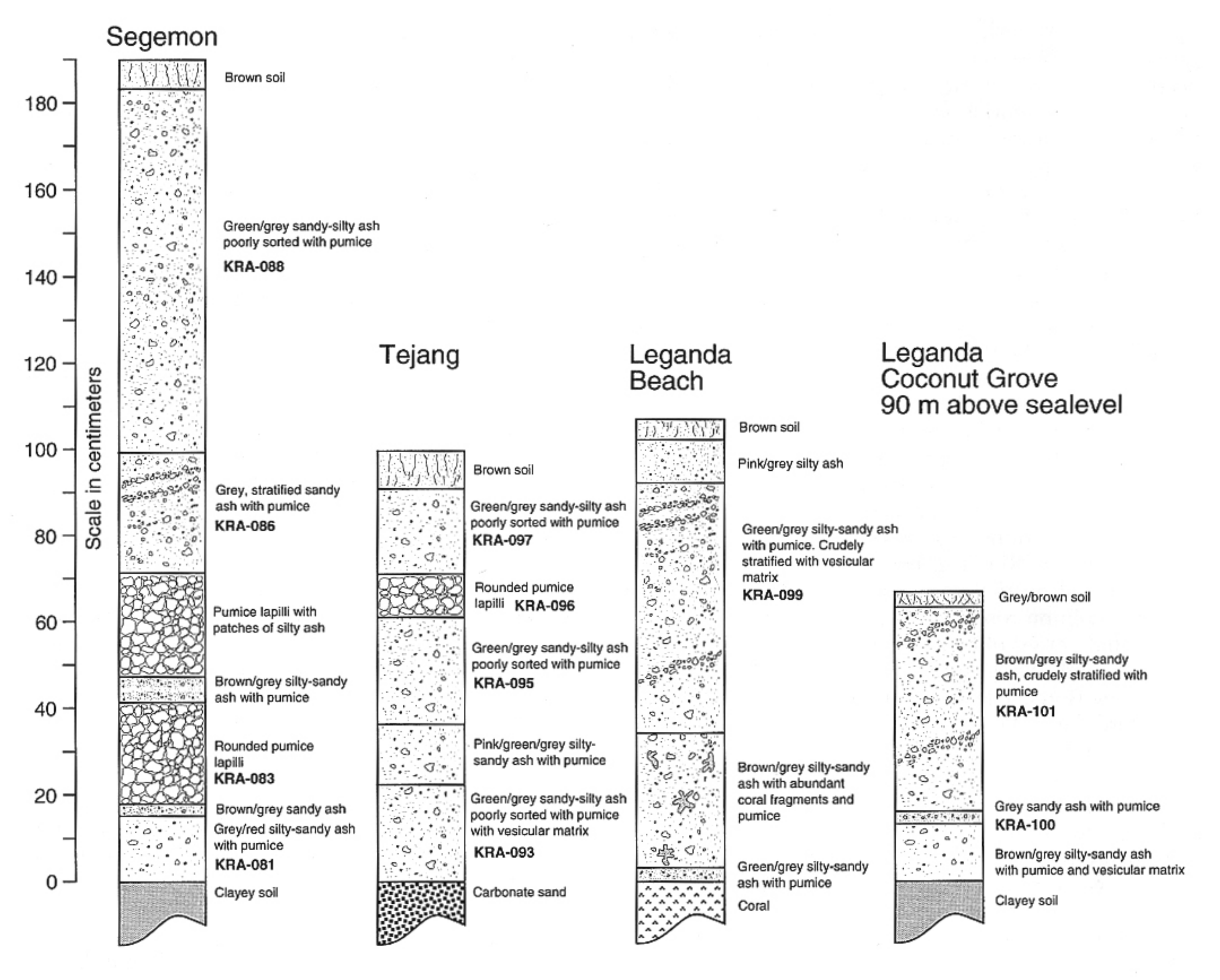
- Components are similar in massive textured samples and land based pyroclastic flows

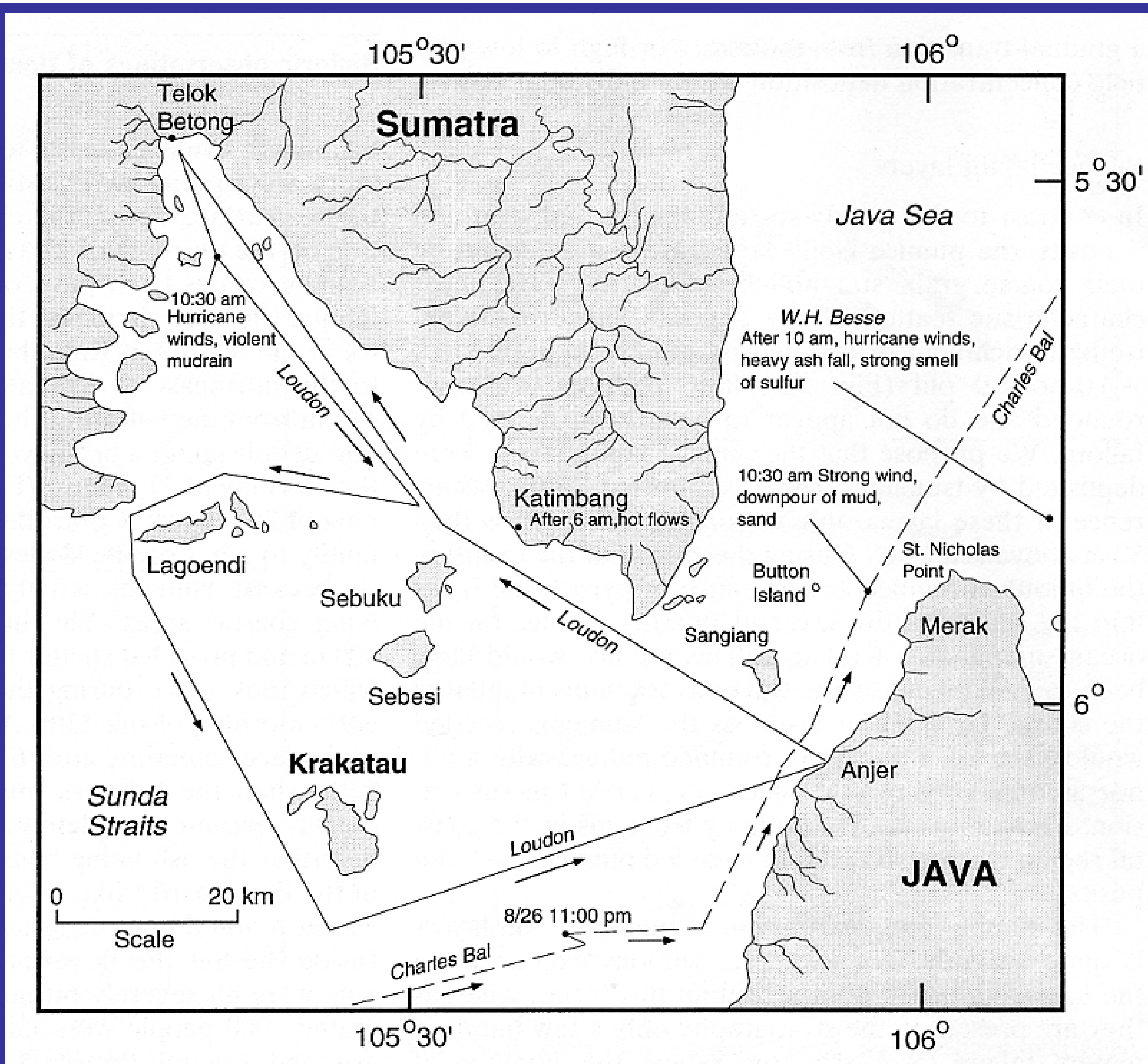
Evidence of mass loss in proximal pyroclastic flow samples

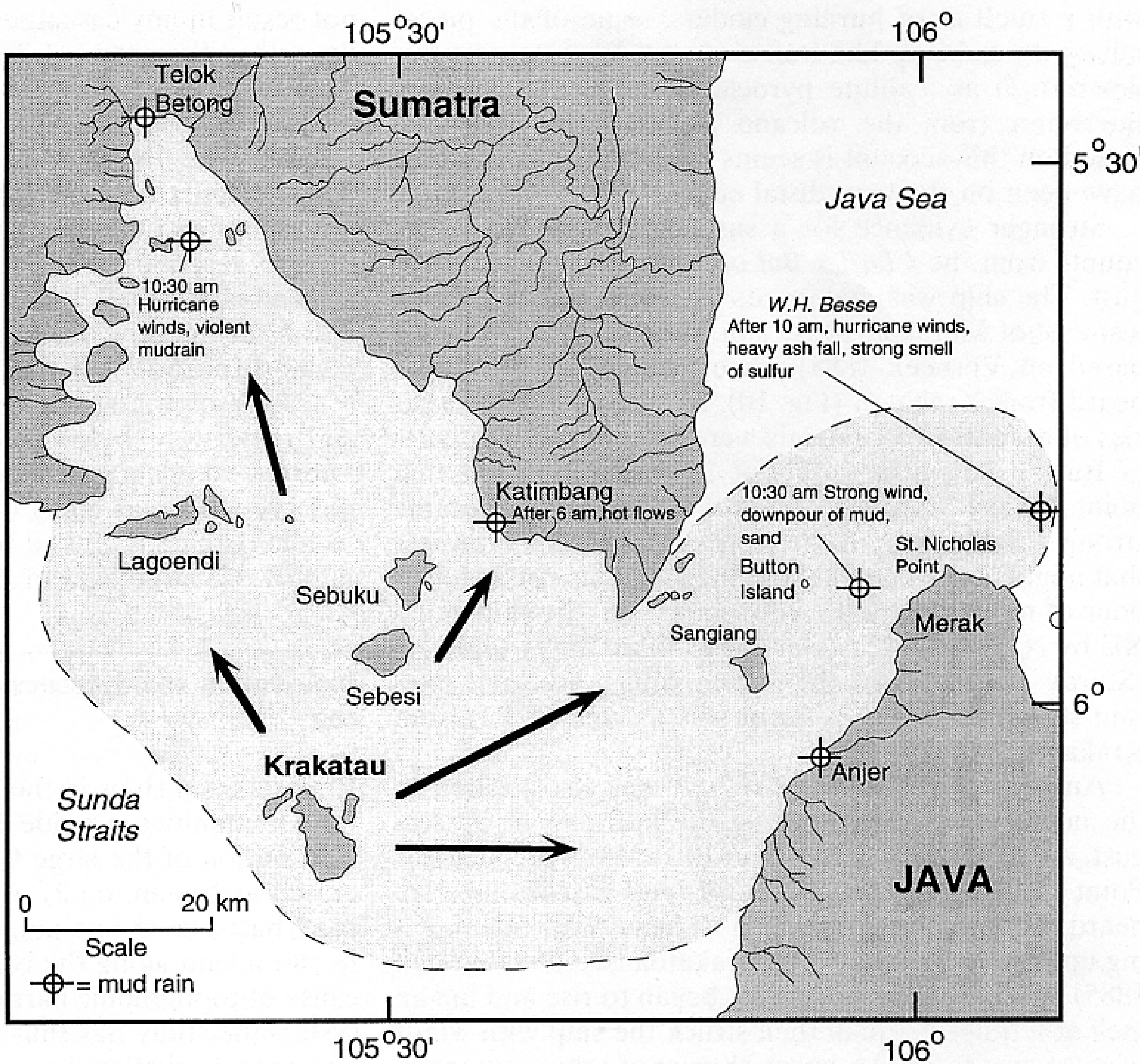


- Land based pyroclastic flow and submarine massive textured samples are crystal enriched
- Mass loss of 18% (glass)

Stratigraphy of 1883 deposits on Sebesi




105°30'
106°
5°30'
6°
Sumatra
Telok Betong
Java Sea
W.H. Besse
After 10 am, hurricane winds, heavy ash fall, strong smell of sulfur
Charles Bal
10:30 am Hurricane winds, violent mudrain
Loudon
Katimbang
After 6 am, hot flows
10:30 am Strong wind, downpour of mud, sand
St. Nicholas Point
Button Island
Merak
Lagoendi
Sebuku
Sangiang
Sebesi
Anjer
Krakatau
Sunda Straits
JAVA
0
20 km
Scale
8/26 11:00 pm


105°30'
106°
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6°
Telok Betong
Sumatra
Java Sea
10:30 am Hurricane winds, violent mudrain
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After 10 am, hurricane winds, heavy ash fall, strong smell of sulfur
Katimbang
After 6 am,hot flows
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St. Nicholas Point
Button Island
Lagoendi
Sebuku
Sebesi
Sangiang
Merak
Anjer
Krakatau
Sunda Straits
JAVA
0
20 km
Scale
= mud rain

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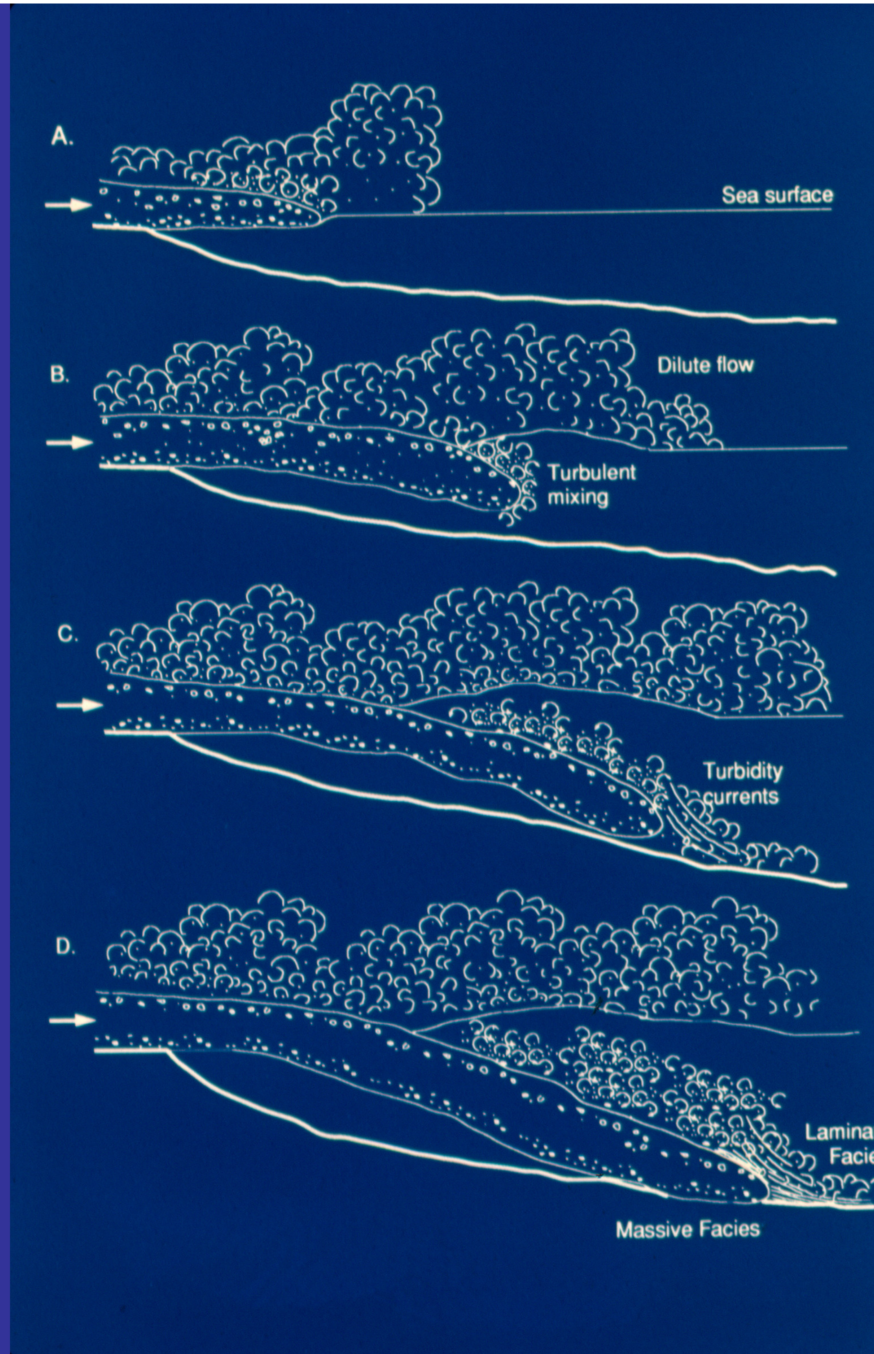
A.
Sea surface
B.
Dilute flow
Turbulent mixing
C.
Turbidity currents
D.
Laminat
Facie
Massive Facies

Summary

- Submarine massive facies recovered in SCUBA cores is indistinguishable from 1883 pyroclastic flow deposits exposed in sea cliffs
- Deposition of submarine massive facies was from deflated component of pyroclastic flows that entered the sea
- Lack of hydraulic fractionation of components, tractional sedimentary structures and high temperature emplacement of massive facies indicates minimal mixing with seawater
- Discharge of voluminous pyroclastic flows into the sea is the most likely cause of devastating tsunamis contemporaneous with this eruption
- Distal pyroclastic deposits from the 1883 eruption on Sebesi, Sebuku, Lagoendi and southwest coast of Sumatra were formed mostly from pyroclastic flows that traveled over the sea for distances of up to 80 km.