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Deformation Bands in Ignimbrite in Shihtiping, Eastern Taiwan

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Introduction

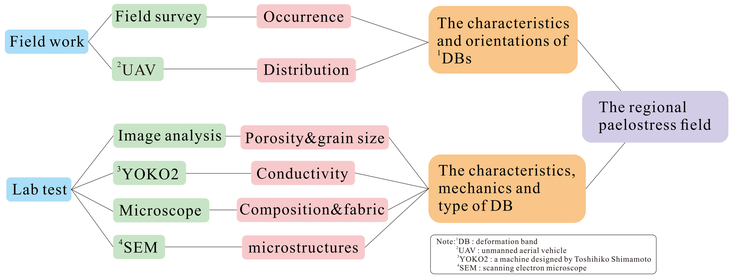
★ **Goal**: This study aims at documenting the occurrence of deformation bands in the field, understanding their formation mechanism and discussing their tectonic implication.

★ **What is deformation band?**

- Tabular structure formed in porous rocks.
- Higher cohesion, lower porosity and permeability due to pore collapse and grain fracture.
- Single (Fig. 5a) or clustering (Fig. 5b) in form.
- Thickness of single band is few millimeters.
- Width of clustering zone varies along its trace and ranges from few to tens of centimeters.
- Smaller offset than slip surfaces (Fossen et al., 2007, e.g. faults).

★ **Motivation**: Volcanic deposits, such as tuff, ordinally exist in Miocene formations in Taiwan. Rocks at Shihtiping are mainly composed by ignimbrite, one type of tuff, where deformation bands are ubiquitous.Deformation bands behave like barriers of fluid flow in host rock because of their characteristics of low porosity and conductivity, Thus, documenting their existence and features is important for the industrials of oil exploration and CO_2 capture and storage.

Method



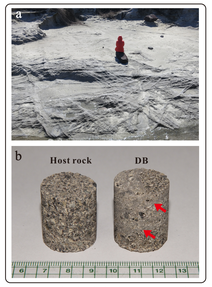


Fig. 4 (a) DBs in the field(b) Samples of lab test

Study Area

★ **Location and lithology** (Fig. 1)

Shihtiping is located at the coast of eastern Taiwan, where rocks are the products of subaerial eruption by Chimei Volcano in late Miocene. The lithology majority is ignimbrite along with pyroclasts in various sizes. The ignimbrites are composed of white vesiculated glassy shard, pumices and loose deposit. Deformation bands are widely distributed in Shihtiping.

★ **Structural setting** (Figs. 2 and 3)

The Takangkou fault with orientation of N20°E which is at the west of Shihtiping. The older Tuluanshan formation thrust up to the younger Paliwan formation. From our filed survey, there is a syncline with N14°E/3°N pass through Shihtiping make the bedding planes opposite dipping.

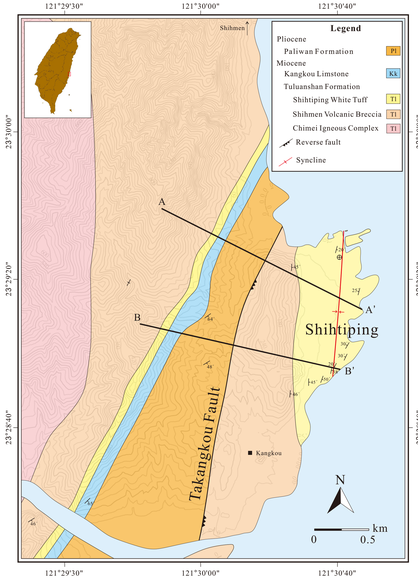


Fig. 2 Geological map of the Shihmen-Kangkou area (Modified from Song and Lo, 1988)

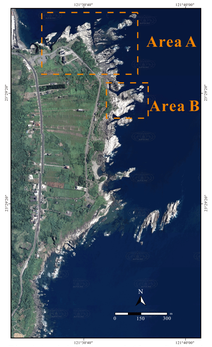


Fig. 1 Aerial photograph (from Safe Taiwan)

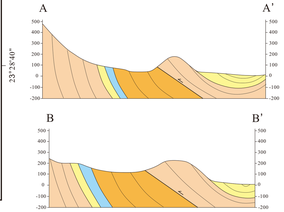


Fig. 3 Profiles of AA' and BB'

Result

★ **Field works**

- Single band (Fig. 5a)is rare; cluster zone (Fig. 5b)is common.
- There are two sets of deformation bands with orientations of ENE (set 1)and WNW (set 2) widely distributed in Shihtiping (Fig. 6). Both of them have high dip angles (Fig. 5c).

Fig. 5 Deformation bands(a) single band(b) cluster zone(c) DBs with an high dip angle

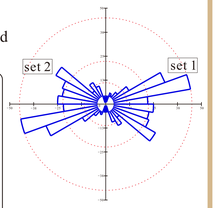
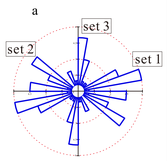


Fig. 6 Rose diagram. The orientation of DB in whole area

- **Area A**

- Three sets of DBs: two widely distributed plus one locally distributed (Fig.7)
- ENE and WNW-oriented DBs : nearly vertically dipping ; NS : 50°-60°dipping (set 3)
- Occurrence of BD : protruding on land (Fig. 8a) but tend to be destroyed and become fissure while adjacent to the sea (Fig. 8b)

Fig. 7 Distribution of DB collected from UAV and field survey (a) orientation in area A. (b) distribution map



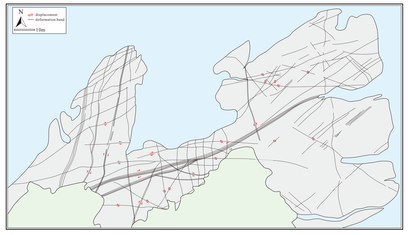
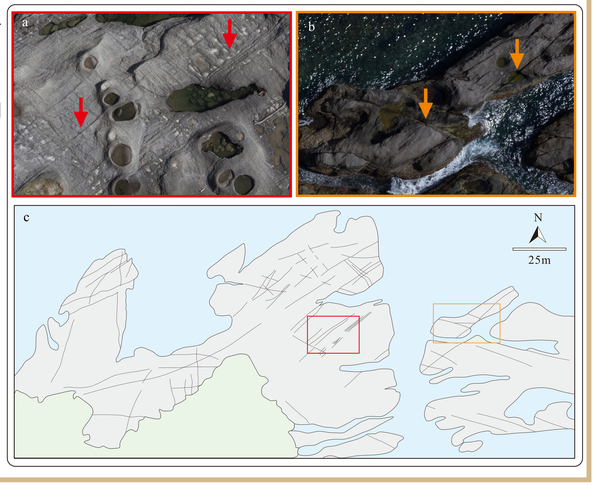


Fig. 8 Distribution of DB(a), (b) aerial photos by UAV (c) distribution map based on aerial photos only



- **Area B**

- Two sets of DBs with orientations of ENE and WNW, respectively. There is a "fault" with ~3 meters of offset composed by a cluster of DBs (Fig. 9). DBs are not restricted in any certain type of tuff (Fig. 12).

Fig. 9 Fault composed by DBs

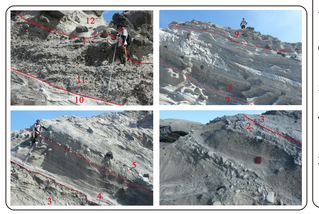


Fig.10 The category of rock units

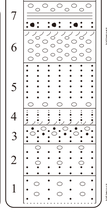


Fig.11 Graphic log

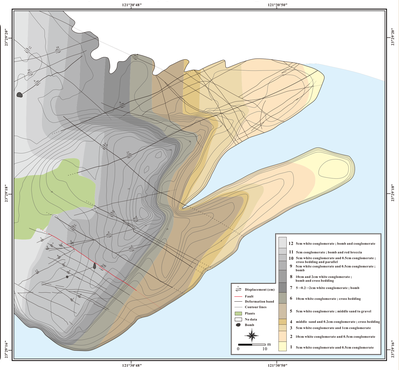


Fig. 12 Detailed geological map

★ **Lab test**

- Porosity of host rock : 17.8% (excluding the host rock in DB cluster zone, e.g. A1-1) Porosity of DB : 4.3% (Fig. 13)
- Mineral composition : plagioclase, hornblende and pyroxene
- Grains are relatively small and intact (i.e. not fractured) in DBs. They seemingly have a preferred shape orientation with the long axes parallel to DB (Figs. 14 and 15).

No.	Porosity of host (%)	Porosity of DB (%)
A1-1	6.64	2.66
A1-5	10.26	6.45
A2-1	14.19	3.50
C1-5	18.98	6.95
C2-4	19.88	X
C2-7	16.46	X
C3-10	9.33	4.77
C6-4	8.60	2.47
C6-5	11.13	2.09
C6-10	16.36	3.04
C7-1	17.46	3.21
C7-4	13.61	7.69
Average	13.58	4.28

Fig.13 Porosities for host rock and DB

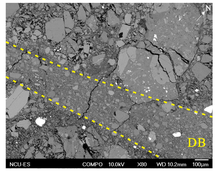


Fig.14 SEM image of DB

Fig.15 DB under microscope

Conclusion

★ **DBs in Shihtiping**:

- are mostly ***mature***, i.e. cluster zone, and ***some*** even ***evolve into faults***.
- are ***compactional shear bands with cataclasis*** (Fig. 16) based on reduction of porosity and evidences for grain crush in host rock and smaller grain size and preferred grain shape orientation in DB.
- are not restricted to any certain type of tuff. It may imply that lithology of rock is insigificant to their formation.

★ The two sets of widely distributed DBs may reflect the regional paelostress state but are not accompanied with any tectonic fault (Fig. 17).

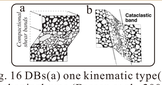


Fig. 16 DBs(a) one kinematic type(b) one mechanical type (Fossen et al., 2007)

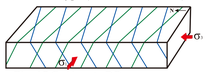


Fig. 17 Conjugate DBs (Modified from Fossen et al., 2011)

Future work

★ Estimating max. buried depth of the host rock, ignimbrite, and the forming depth of deformation bands.

★ Reasoning the forming sequence of structures in Shihtiping.

★ Explaining why deformation bands tend to turn into fissures while adjacent to the sea.

References

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