出國報告（出國類別：研究）

赴日本神戶及四國地區移地研究

服務機關：交通部中央氣象局

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出國期間：民國 106 年 04 月 10 日至 04 月 15 日

報告日期：民國 106 年 05 月 22 日

摘 要

為強化我國地震監測預警、海嘯警報業務與防災科技應用及地震防護教育之推廣，中央氣象局地震測報中心呂佩玲副主任與何美儀技正赴日本神戶及四國地區研習，並強化與日本相關單位之後續技術合作、訓練觀摩以及未來的長期交流。呂員等 2 人在日本香川大學金田義行教授協助安排下，參訪以下研習單位，包括神戶減災館及香川大學“四國危機管理教育・研究・地域連携推進機構”。研習所見參訪單位可供中央氣象局借鏡處已建議逐步落實於中央氣象局地震監測預警、海嘯警報業務與防災科技應用及地震防護教育推廣業務之執行，並建議持續強化與日方相關單位之技術交流與合作。

目 錄

一、目的

臺灣位於歐亞大陸板塊與菲律賓海板塊交接處，是典型板塊碰撞下的大陸邊緣島嶼，因此地震、海嘯與火山等天然災害，對於人口稠密的臺灣是相當大的威脅，近年來中央氣象局(以下簡稱氣象局)地震測報中心在地震速報、地震預警發展方面已卓有成效，在 2016 年 5 月配合國家通訊傳播委員會(NCC)針對 4G 無線通訊架構，推動災防告警細胞廣播訊息系統（Public Warning System，PWS），利用其快速、大量廣播之特性，由氣象局「地震速報系統」介接先行營運測試，於地震發生時，快速發送地震告警資訊通知民眾應變，以提升強震即時警報資訊之通報與應用成效。面對多樣的災害預警訊息，民眾在收到這些警訊時該如何因應？反而成為災害危機應對的成敗關鍵。

日本的地體環境與臺灣相似，均位於板塊交界邊緣，因此地震、海嘯與火山亦為日本地區最為嚴峻之天然災害。日本在地震、火山及海嘯監測方面擁有非常豐富的實務經驗，其針對地震、火山及海嘯研究、活動監測及預警系統之運作等，均位居國際領先地位，是我們很好的學習目標，同時日本也是個記取地震教訓的國家。日本關東地區於 1923 年 9 月 1 日發生規模 8.0 的大地震，死傷慘重；因此日本於 1960 年訂定 9 月 1 日為日本的防災日。每到 9 月 1 日，全民與企業必一同進行演練，演練劇本來自於地震災害潛勢圖資的分析成果。日本的活動斷層、地震災害等模擬結果都會公開於媒體、書籍出版、防災訓練、專業防災認證以及學生書本教材中，顯見人民相信大地震災害將會再臨。平常更積極進行演練，以求災害來臨時，可以多一些生存機會。為此，我們必須努力向世界各國先進單位研習與合作，藉由學習這些國際單位的科技開發與實務運作，來提昇並落實我國相關防災業務之推動。

為強化我國地震監測預警、海嘯警報業務與防災科技應用及教育宣導之推動，氣象局指派地震測報中心呂佩玲副主任與何美儀技正 2 員赴日分別研習相關技術，呂員負責未來雙方合作備忘錄商談事宜，何員負責地震預警與教育推廣相關技術與經驗之交流。相關成果將落實於氣象局地震預警與防災業務之應用，並強化後續臺日雙方於科技資源、研究合作、訓練觀摩以及其他地震、海嘯相關之長期交流合作機會。

二、研習參訪單位簡介

本次行程在日本香川大學金田義行教授協助安排下，除邀請氣象局同仁外，尚邀請健行科技大學鄭世楠副教授同行參訪並參加研討會，參訪與研習單位包括“神戶減災館-人與防災未來中心” (Disaster Reduction and Human Renovation Institution-Kobe，簡稱神戶減災館)及香川大學“四國危機管理教育・研究・地域連携推進機構” (Institute of Education, Research and Regional Cooperation for Crisis Management Sikoku; IECMS, 簡稱四國危機管理教育機構)，依序簡介如下：

神戶減災館是為了把 1995 年阪神・淡路大震災中的經驗和教訓傳承給後世，並致力於減輕國、內外災害受害程度的震災紀念館。

國立香川大學位於日本四國地區，為日本四國最佳大學，本次參訪行程包括參觀危機管理教育機構暨舉辦小型雙邊研討會並拜會機構長，此外雙方也將討論未來合作事宜(含未來簽訂合作備忘錄事宜)。

國立香川大學四國危機管理教育機構成立於 2016 年 4 月，下設危機管理先端教育研究中心及地域強韌化研究中心 2 大中心。金田教授於 2016 年 4 月接任此機構之副機構長及地域強韌化研究中心中心長之職。本次應他邀請，預計參觀其地域強韌化研究中心之三維危機處理反應模擬器(3D Risk Management Response Simulator)，所展示之地震逃生模擬系統。

三、研習過程

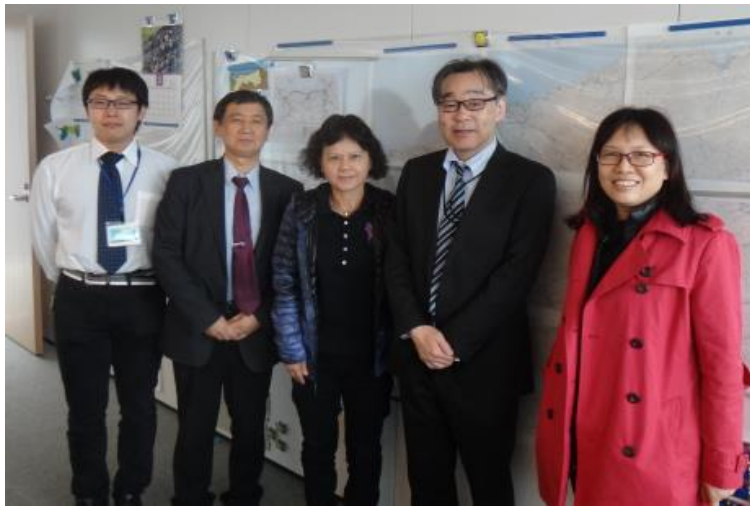
本次研習行程如下:

4 月 10 日（星期一）~4 月 11 日(星期二) 神戶減災館考察與交流研習

- 4 月 10 日（星期一）由桃園國際機場搭乘中華航空航班至日本關西機場。再搭乘利木津巴士前往神戶三宮住宿地點並與香川大學金田義行教授會合。
- 4 月 11 日（星期二）上午 9 點在金田義行教授陪同下，參訪神戶減災館，同時拜會芳永和之研究部長與本塚智貴研究員（照片 1 a、b）。1995 年 1 月 17 日，擁有 350

萬密集人口，肩負日本經濟活動中樞重任，從淡路北部到神戶市以及阪神地區，發生內陸城市直下型地震。電氣、自來水、瓦斯及交通運輸機構等生命線受到毀滅性打擊，許多居民被迫不得不在避難所過著嚴酷的生活。老舊木製住宅密集區域因地震導致大規模倒塌與火災、6,434 人死亡、43,792 人受傷、住家受害（全毀・半毀）249,180 棟。當時這樣慘重的震災災情給日本帶來了極大的震撼，而開始反思地震預測與預警孰重孰輕，而神戶減災館則是為傳承給後代阪神・淡路大震災的經驗與教訓，傳述改變地域歷史的重大情節而設立，運用特殊攝影與特殊效果，體驗地震發生瞬間，利用大型影像視頻與音響以體驗那駭人、可怕的地震。並以多樣化的資料來解說重建、復原過程，及當時生活與市街情景，並透過實驗和遊戲等方式學習自然災害與防災、減災方面的知識。該中心與臺灣九二一地震教育園區類似，除展示 1995 年阪神・淡路大地震相關資訊（照片 1 c 、 d）外，同時肩負地震災害調查工作並於災害地震發生後為地方政府提供專業諮詢，照片 1 e 即是與該中心研究員討論 2016 年 10 月 21 日造成神戶地區的災害地震，並交換心得。較特殊的是該館由該地區歷史地震研究分析，1605 年規模 7.9 (簡寫為 M7.9)慶長地震、1707 年寶永地震(M8.4)、1854 年安政東海地震(M8.4)與安政南海地震(M8.4)、1944 年東南海地震(M7.9)、1946 年南海地震(M8.0)，推估東南海與南海大地震(M>8.0)週期約一百年，並將東南海與南海大地震當作想定地震(照片 1 f，估算並模擬可能造成的海嘯高度(照片 1 g)與到時(照片 1 h)，並以此進行災害防救宣導。

(a)



(b)

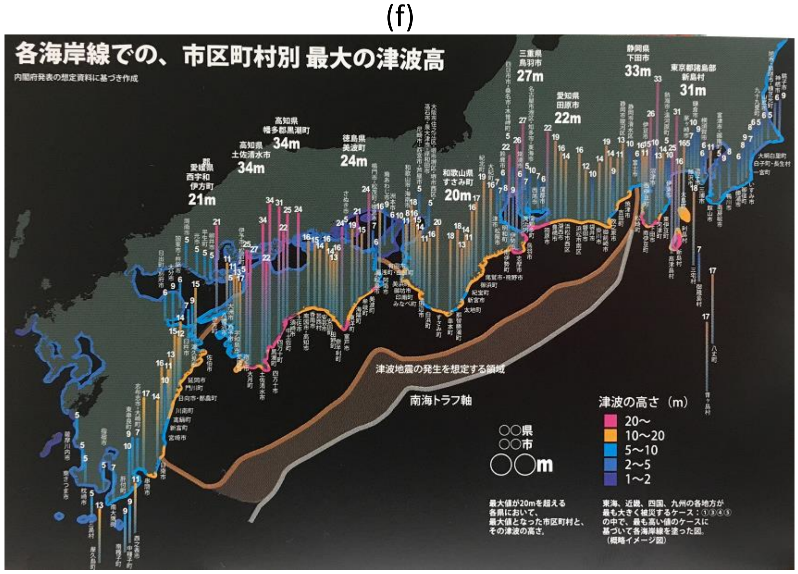
(c)

(d)


(e)

全国地震動予測地図
確率論的地震動予測地図
東南海・南海地震は近づいている
どれかが動く？

(f)



各海岸線での、市区町村別 最大の津波高
内閣府発表の想定資料に基づき作成
三重県 鳥羽市 27m
静岡県 下田市 33m
東京都諸島部 新島村 31m
愛知県 田原市 22m
高知県 幡多郡黒潮町 34m
徳島県 美波町 24m
高知県 土佐清水市 34m
愛媛県 西宇和 伊方町 21m
和歌山県 すさみ町 20m
津波地震の発生を想定する領域
南海トラフ軸
〇〇県
〇〇市
〇〇m
最大値が20mを超える各県において、最大値となった市区町村と、その津波高さ。
津波の高さ（m）
20～
10～20
5～10
2～5
1～2
東海、近畿、四国、九州の各地方が最も大きく被災するケース：①③④⑤の中で、最も高い値のケースに基づいて各海岸線を塗った図。（概略イメージ図）

(g)

(h)

照片 1、參訪神戶減災館「阪神・淡路大震災紀念－人與防災未來中心」：(a)入口處與金田義行教授(右)合照；(b)拜訪芳永和之研究部長(右二)與本塚智貴研究員(左一)；(c) 遭阪神地震破壞的阪神高速道路橋墩(後)；(d) 模擬 1995 年神戶地震災害現場；(e) 與該中心研究員討論 2016 年 10 月 21 日造成神戶地區災害的地震；(f)由歷史地震建立假想地震－南海地震；(g)假想地震造成的海嘯高度；(h)假想地震造成的海嘯到達時間。

4 月 12 日(星期三)：神戶－香川縣高松市及小豆島野外地質考察

- 本日上午由金田教授陪同由神戶市搭乘高速巴士前往四國香川縣高松市。下午則由香川大學藤澤一仁教授(地域強韌化研究中心副中心長)、磯打千雅子副教授與藤川幸子小姐陪同前往小豆島野外地質考察，主要是實地觀看火山地形、花崗岩與安山岩。現場討論照片如照片 2 a ~ b，香川大學展示館所陳列火成岩標本如照片 2 c。

(a)

(b)

(c)

照片 2、小豆島實地考察：(a)、(b)花崗岩現場；(c)香川大學展示館所陳列火成岩標本。

4 月 13 日(星期四)拜會香川大學四國危機管理教育機構及召開 MOU 第 1 次工作會議

- 本日上午拜會香川大學副校長暨四國危機管理教育機構機構長筧善行博士(照片 3 a)。同時與香川大學洽談未來臺灣與日本在地震災害防救科學上的合作，以及該大學與氣象局在地震預警、災害預防、資料與研究成果交流的合作。
- 下午則在香川大學幸町校區研究交流棟 6F 召開氣象局與香川大學合作研究備忘錄簽訂第 1 次工作會(照片 3b ~ c)，分別就未來合作項目及工作期程進行討論 (詳細會議紀錄內容及雙方討論文件詳附錄 1)。

(a)

(b)

(c)

照片 3、拜會與洽談未來合作事宜：(a)拜會筧善行機構長(副校長，前中)；(b) 雙邊合作洽談； (c) 雙邊洽談人員合影。

4 月 14 日(星期五) 三維危機處理反應模擬器體驗，與小型研討會論文發表

本日上午在金田教授陪同下，至香川大學工學院校區進行三維危機處理反應模擬器體驗(3D Risk management response simulator)，在未來 30 年內日本南海發生規模大於 8.0 (M>8.0)的破壞性地震的機率相當高，香川大學四國危機管理教育機構將此南海海槽大地震(The Nankai Trough Earthquake) M>8.0 做為想定地震，針對學校教師在此想定地震下，發展一套三維危機處理反應模擬系統，主要目的是訓練學校教師實際的災難應對能力，詳細資料如附錄 2 所示。參訪過程中，並親自體驗三維危機處理反應模擬系統(照片 4 a ~ f)。其主要為一虛擬小學校園環境，當老師與學童在教室時，一旦發生地震時該如何因應？該系統準備數種不同模擬情境(含地震與海嘯來襲等不同情境)，使用者可搭配使用現場桌椅，來練習標準的避難處置步驟。該系統結合虛擬實境與真實環境，創造出一種混合實境、互動式教學，讓使用者可更融入災害現場環境，強化避難練習體驗，以減少因地震等災害發生時受傷機率。

例如教師(由體驗者擔任)在一聽到預警聲響時，除了指示學生馬上採取趴下、掩護及穩住 3 步驟保護自己外，若還有多餘時間，是否可先把門打開以防震動過後逃生通道受阻(或平常即可先指定最靠近門的學生負責)，又若教師只顧著安撫學生反而忘記保護自己致受傷等種種狀況，皆會根據體驗者當場所下的指令而有不同結果，另外也會將其錄影後再重播一一檢討如何改進，讓體驗者深思及反省當下的反應與應對還有那裡不足並思改進之處。因此當政府希望將預警訊息逐步普及至全國民眾時，學校老師或每個家庭成員是否也要先預擬一套應變策略或劇本，才不會在接到警告訊息時徒然呆立觀望不知所措，讓寶貴的預警時間流失而無作為，喪失了預警減災的功效。

同為地震頻繁的臺灣，也面臨相似的災害環境，可試著引入類似構想，以達推廣震災教育與展示目的。本次能與該中心進行相關業務交流，對我們推動未來防災教育推廣工作，必有助益。

(a)

(b)

(c)

(d)

(e)

(f)

照片 4、參訪香川大學三維危機處理反應模擬系統(3D Risk Management Response Simulator)系統：(a)拜訪模擬系統工作人員；(b)內部電腦儀

器設備；(c)模擬現場與各項設備；(d), (e), (f)親自體驗三維危機處理反應模擬系統。

- 下午則在香川大學工學院區四國危機管理教育機構 3 樓會議室進行小型研討會，並交換研究心得與資料(如照片 5)。研討會資料如附錄 3 所示。由鄭世楠老師先介紹臺灣歷史地震資料的整理與建檔，接著由何技正介紹臺灣的地震觀測，最後由呂副主任介紹氣象局地震測報中心在防震減災方面的成果與現況。

(a)

(b)

(c)

照片 5、香川大學 IECMS 進行研討會情形：(a)呂佩玲副主任報告；(b)何美儀技正報告；(c) 與會人士合影。

4 月 15 日（星期六）由高松機場，搭機返臺。

四、心得與建議

中央氣象局之地震測報作業已有多年實務運作經驗與實績，近年來更努力研發及推動強震即時警報之通報與防災應用，本次研習提供心得與建議如下：

（一） 日本極重視藉由歷史地震研究預測破壞性大地震發生的必然性，並模擬可能發生的各種災害，進而強力宣導防、減災及應變教育的努力，非常值得臺灣參考與借鏡，未來值得研議與香川大學進一步合作

此次移地研究與參訪收穫良多，尤其是日本藉由歷史地震預測東南海－至南海地區破壞性大地震(M>8)的回歸周期約 100 年，未來 30 年發生的機率相當高，甚至將 M > 8.0 南海海槽地震(The Nankai Trough Earthquake)做為想定地震(假想敵)，預估各項可能發生的災害，包括海嘯到時與波高等，並依此模擬結果進行各項研究、災害演練與防、救災教育宣導(如照片 6)，非常值得臺灣參考與借鏡。另，日本所開發的互動體驗式的教育宣導設施，也非常值得引進臺灣加以改良推廣。

目前氣象局計畫整理中的歷史地震波形資料庫，亦收錄了相當多的日本災害地震，其中包括 1944 年東南海地震(M7.9)與 1946 年南海地震(M8.2)(照片 7)，未來值得研議與香川大學進一步合作。

（二） 持續進行與香川大學合作研究備忘錄的簽訂事宜

本次赴日行前，日方即表達欲與氣象局簽訂合作研究備忘錄的意願，同時藉由此行拜會香川大學副校長兼機構長筧善行博士，商談未來臺灣與日本在地震災害防救科學上的合作，及與氣象局在地震預警、災害預防、資料與研究成果交流的合作。更在香川大學召開氣象局與香川大學合作研究備忘錄簽訂第 1 次工作會，分別就未來合作項目及工作期程進行討論。返臺後我們將持續進行後續相關連繫工作。

照片 6、讀賣新聞 2017 年 4 月 2 日報導預測未來 30 年南海海槽地震(The Nankai Trough Earthquake) 發生機率與災害。

照片 7、臺灣歷史地震波形資料庫收錄 1946 年南海地震(M8.2)波形紀錄，台南測候所威赫式地震儀收錄之波形。

五、附錄

附錄 1、氣象局與香川大學合作研究備忘錄簽訂第 1 次工作會會議紀錄及雙方所提供之討論文件

- **Summary of the meeting at Kagawa University**

Date: April 13, 2017
Time: 13:00-14:30
Place: Meeting room, Saiwai-cho Campus, Kagawa University, Japan
Attendees:
Ms.Leu and Ms.Ho (CWB),
Dr. Cheng (Chien Hsin University of Science and Technology)
Dr. Kaneda, Prof. Fujisawa, Dr. Isouchi and Mr. Sangawa (IECMS, Kagawa Univ.)
Mr. Nagatake and Mr. Ueta (International Office, Kagawa Univ.)
Ms. Ohmori (Research Cooperation Group, Kagawa Univ.)
Chair: Dr. Kaneda

Discussion Summary:
With regard to future collaboration between Kagawa University (KU) and The Central Weather Bureau, Taiwan (CWB), they have agreed as follows:

1. Based on the template of the Memorandum of Understanding(MOU) shown by KU, CWB will examine if there is anything they should revise. After that, they will conclude MOU, as proof of mutual cooperation in the future, in August.

2. Regarding the details of the collaboration, they will discuss after concluding MOU to make efforts to conclude the Implement of Agreement, which will be discussed with using CWB proposal form.

3. Concerning the signing ceremony of the MOU, it can be held at CWB in August and Dr. Kakehi, Trustee, will attend on behalf of KU. On the other hand, we will not eliminate the chance to hold the ceremony at KU and Dr. Nagao, President of KU, will attend.

Recorded by Mr.Ueta

附錄 1 (續)

- 我方提供的備忘錄草稿

MEMORANDUM OF UNDERSTANDING
FOR SCIENTIFIC COOPERATION
BETWEEN
THE CENTRAL WEATHER BUREAU OF THE REPUBLIC OF CHINA (TAIWAN)
AND
THE KAGAWA UNIVERSITY, JAPAN

The Central Weather Bureau of the Ministry of Transportation and Communications in the Republic of China (Taiwan) and The Kagawa University, Japan (hereinafter referred to as the Parties), being desirous to enter into a Memorandum of Understanding (hereinafter referred to as the MOU) with a view to enhance the friendly relationship between the Parties and collaboration in the fields of natural disaster prevention and mitigation, have agreed upon the following :

Article 1 The Parties agree to encourage and promote cooperation in abovementioned fields of technological research and development, technology strategies for disaster risk reduction, exchange visits, exchange of scientific and technical information and data, and training.

Article 2 The execution of any specific project decided on by the Parties shall require separate prior written agreement between both Parties. Each specific agreement shall contain all major details of the execution of the project concerned.

Article 3 When agreed, the activities concerned shall be implemented in accordance with the prevailing laws and regulations in the relevant place in which the activity is being carried out.

Article 4 No financial commitments are involved in this Memorandum of Understanding and each party shall be responsible for financing the work that is undertaken under its direction or by its staff, except where otherwise agreed to by both Parties.

Article 5 This Memorandum of Understanding shall come into effect on the date of the last signature, and may be terminated by either Party with a written notice two months in advance.

Central Weather Bureau, Ministry of Transportation and Communications, Taiwan

____
Dr. Tzay-Chyn Shin
Director-General
Date: ________________

Kagawa University, Japan

____
Dr. Kakehi
Dean
Date: ________________

附錄 1 (續)

- 對方(香川大學)提供 MoU(MEMORANDUM OF UNDERSTANDING)草稿

MEMORANDUM OF UNDERSTANDING
between
Central Weather Bureau
and
Kagawa University

Kagawa University, Japan, and Central Weather Bureau, Taiwan wishing to establish relation between the two organizations, agree to cooperate with each other as follows.
Subject to mutual consent, the areas of cooperation will include any program offered at either party as thought desirable and visible on either side where both sides think will contribute to the fostering and development of a cooperative relationship between the two parties. Cooperation shall be through such activities as:

1. Exchange of faculty members, staffs and researchers
2. Joint research activities and publications
3. Joint educational/research programs/symposiums
4. Special short-term academic programs
5. Exchange of academic materials and other information

The terms of cooperation for each specific activity implemented under this Memorandum of Understanding (MoU) shall be mutually discussed and agreed upon in writing by both parties prior to initiation of that activity. Any such agreements entered into, as outlined above, will form appendices to this MoU. This MoU is valid from the date of signing for the duration of 5 (five) years and can be extended upon mutual consent.
Details of this MoU may be revised or amended at any time by mutual consent.
In witness whereof, the parties here to have offered their signatures:

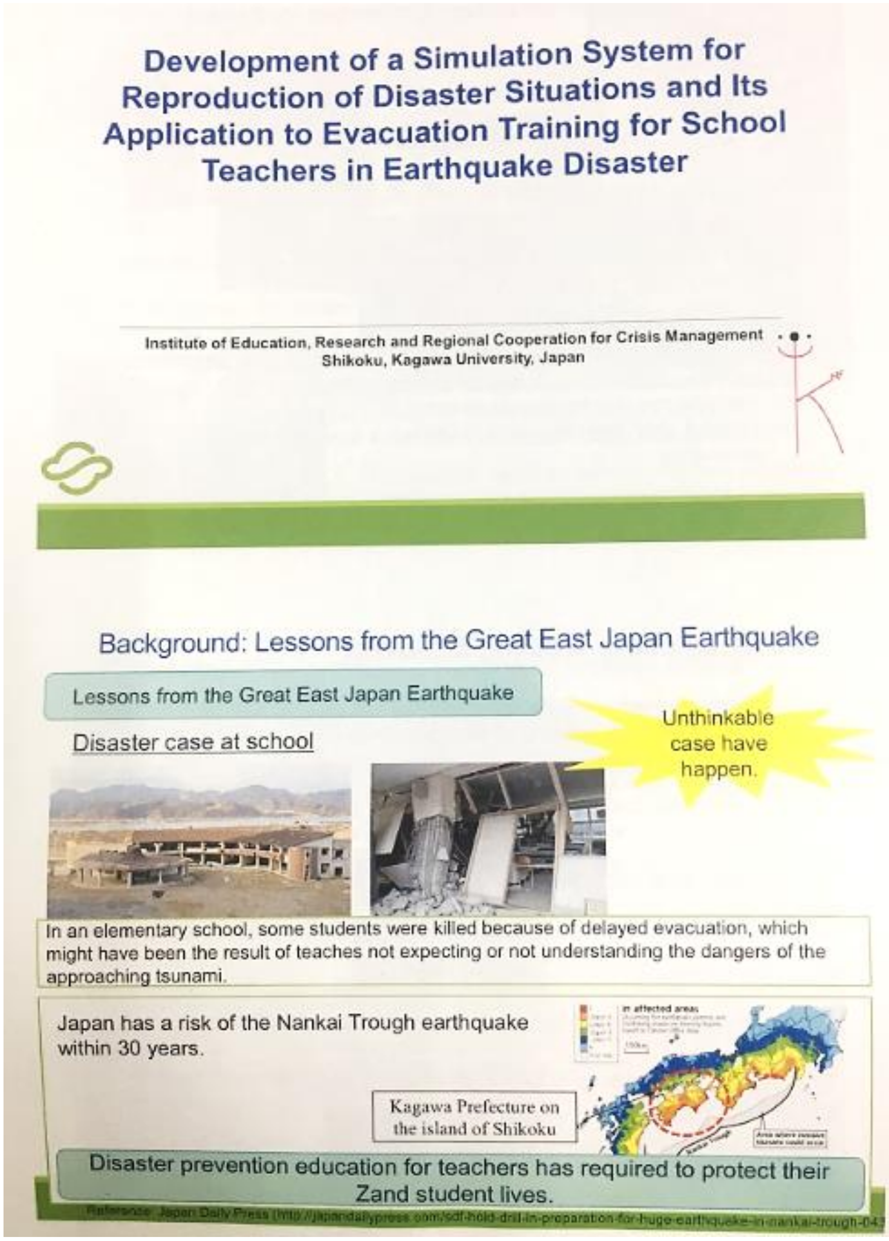
Prof. Seigo Nagao, MD., Ph.D.
President,
National University Corporation
Kagawa University

Date: ______________________________

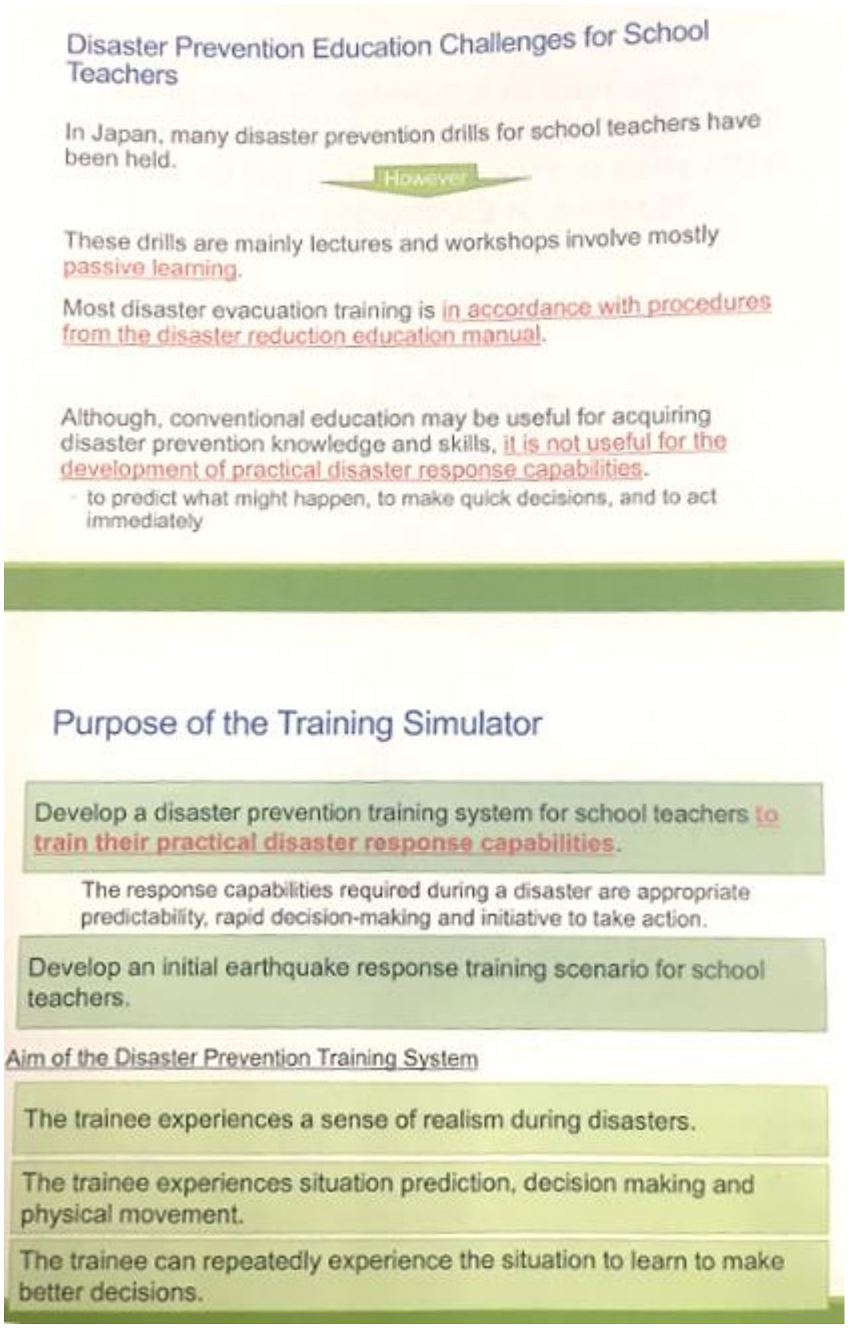
Tzay-Chyn Shin
Director-General,
Central Weather Bureau

Date: ______________________________

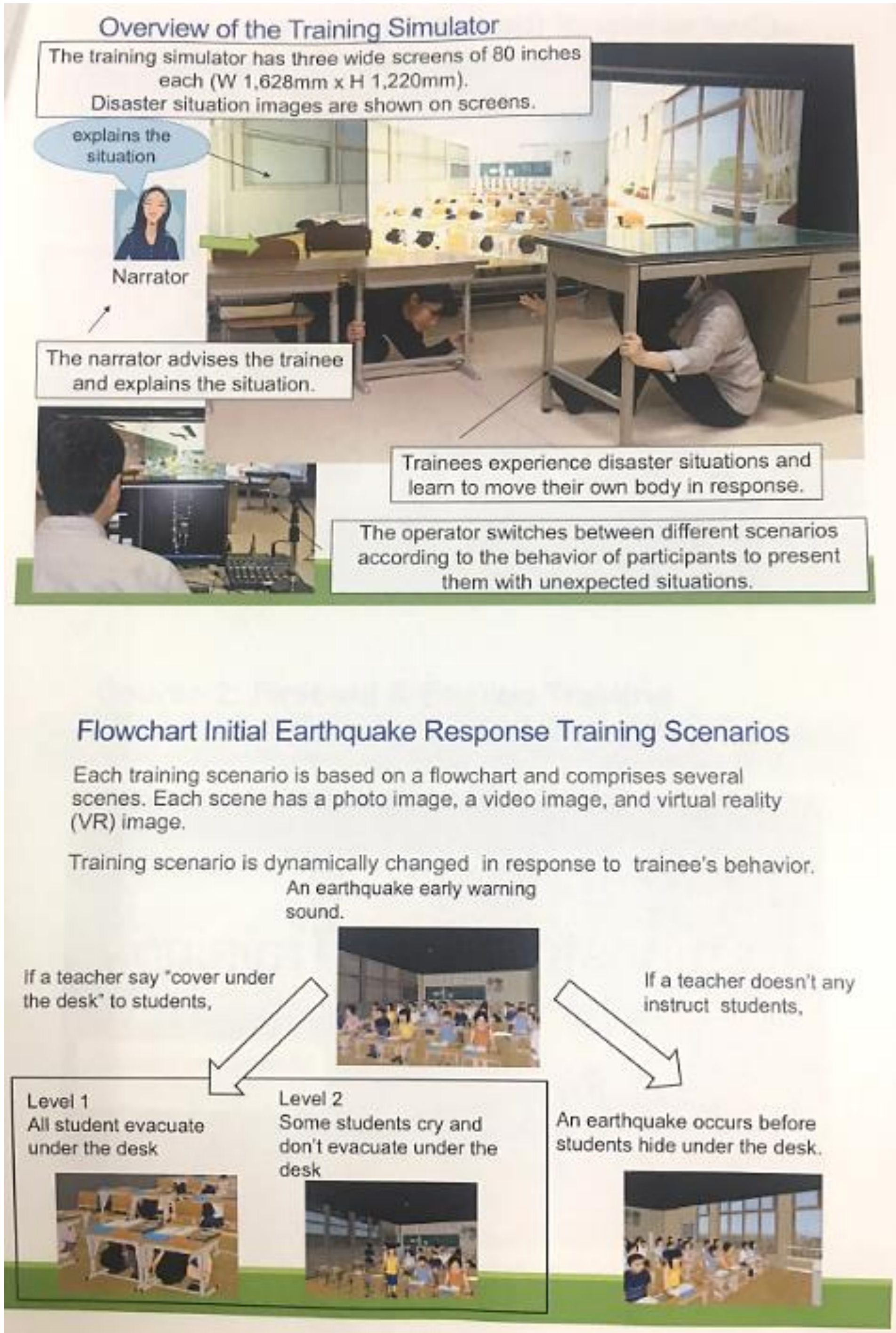
附錄 2、三維危機處理反應模擬器(3D Risk management response simulator)介紹資料



附錄 2 (續)


Disaster Prevention Education Challenges for School Teachers
In Japan, many disaster prevention drills for school teachers have been held.
However
These drills are mainly lectures and workshops involve mostly passive learning.
Most disaster evacuation training is in accordance with procedures from the disaster reduction education manual.
Although, conventional education may be useful for acquiring disaster prevention knowledge and skills, it is not useful for the development of practical disaster response capabilities.
to predict what might happen, to make quick decisions, and to act immediately
Purpose of the Training Simulator
Develop a disaster prevention training system for school teachers to train their practical disaster response capabilities.
The response capabilities required during a disaster are appropriate predictability, rapid decision-making and initiative to take action.
Develop an initial earthquake response training scenario for school teachers.
Aim of the Disaster Prevention Training System
The trainee experiences a sense of realism during disasters.
The trainee experiences situation prediction, decision making and physical movement.
The trainee can repeatedly experience the situation to learn to make better decisions.

附錄 2 (續)



Overview of the Training Simulator

The training simulator has three wide screens of 80 inches each (W 1,628mm x H 1,220mm).
Disaster situation images are shown on screens.

explains the situation

Narrator

The narrator advises the trainee and explains the situation.

Trainees experience disaster situations and learn to move their own body in response.

The operator switches between different scenarios according to the behavior of participants to present them with unexpected situations.

Flowchart Initial Earthquake Response Training Scenarios

Each training scenario is based on a flowchart and comprises several scenes. Each scene has a photo image, a video image, and virtual reality (VR) image.

Training scenario is dynamically changed in response to trainee's behavior.

An earthquake early warning sound.

If a teacher say "cover under the desk" to students,

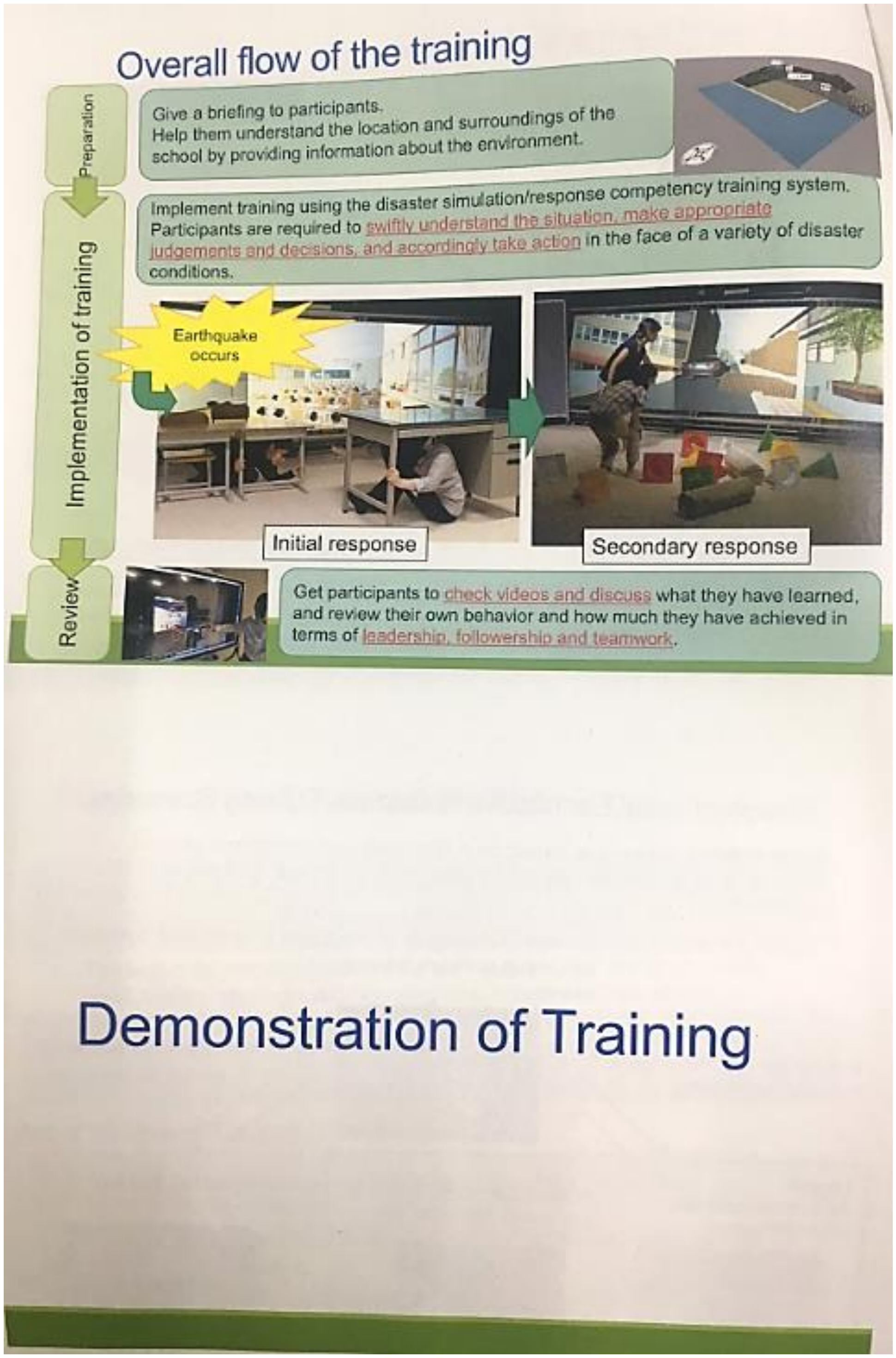
If a teacher doesn't any instruct students,

Level 1
All student evacuate under the desk

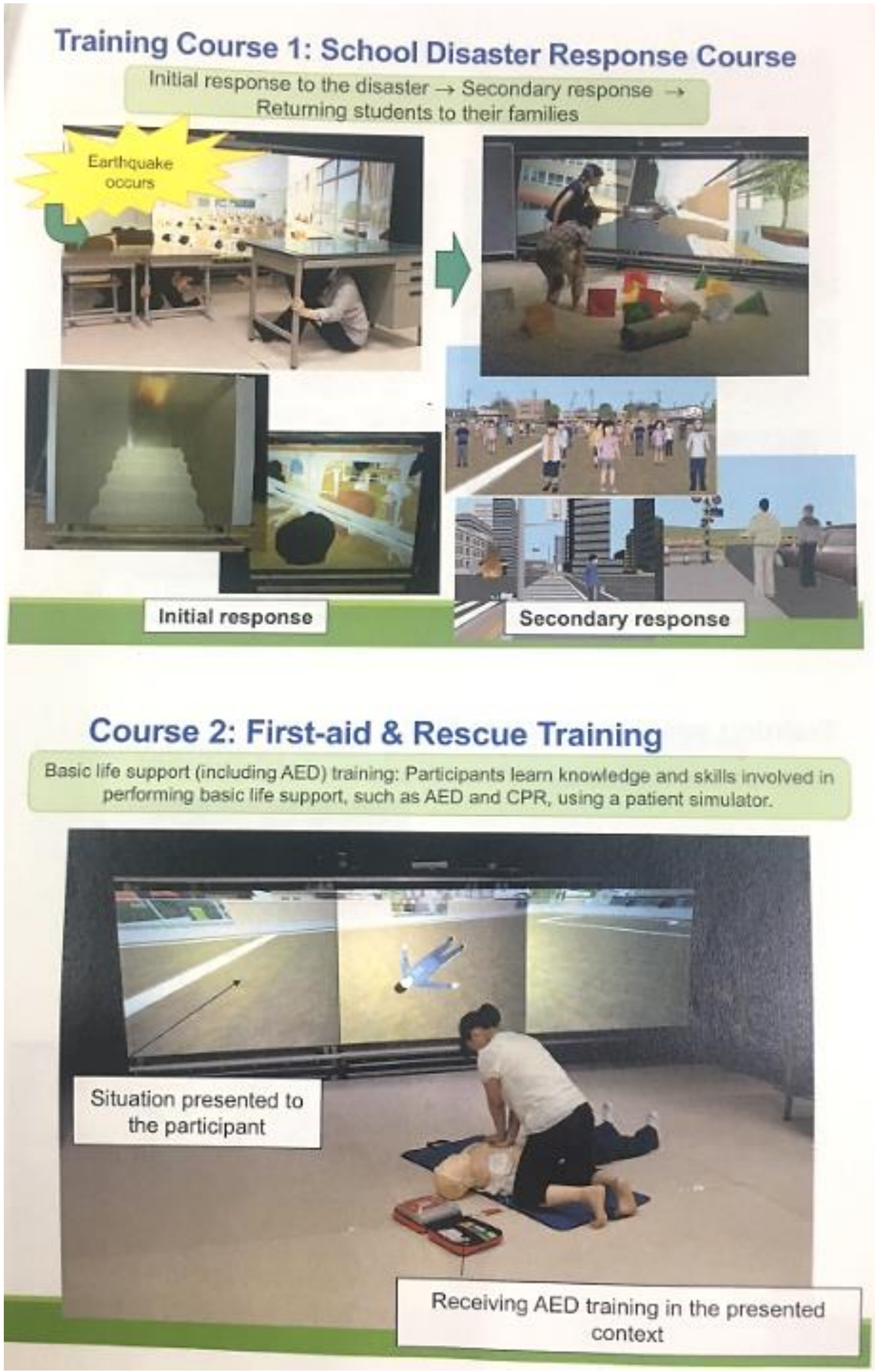
Level 2
Some students cry and don't evacuate under the desk

An earthquake occurs before students hide under the desk.

附錄 2 (續)


Overall flow of the training
Preparation
Give a briefing to participants.
Help them understand the location and surroundings of the school by providing information about the environment.
Implementation of training
Implement training using the disaster simulation/response competency training system.
Participants are required to swiftly understand the situation, make appropriate judgements and decisions, and accordingly take action in the face of a variety of disaster conditions.
Earthquake occurs
Initial response
Secondary response
Review
Get participants to check videos and discuss what they have learned, and review their own behavior and how much they have achieved in terms of leadership, followership and teamwork.
Demonstration of Training

附錄 2 (續)


Training Course 1: School Disaster Response Course
Initial response to the disaster → Secondary response → Returning students to their families
Earthquake occurs
Initial response
Secondary response
Course 2: First-aid & Rescue Training
Basic life support (including AED) training: Participants learn knowledge and skills involved in performing basic life support, such as AED and CPR, using a patient simulator.
Situation presented to the participant
Receiving AED training in the presented context

附錄 2 (續)


Training session example (1/3)
Takamatsu City Board of Education: School Safety Management Training (January 5, 2015)
Training was provided to 105 teachers (kindergarten, elementary school, junior high school and high school teachers) in Takamatsu City.
Initial response training
Video-based review
Returning students to their families
Evacuation drill (implemented by Mr. Matsuo from the Disaster Education Center)


Training session example (2/3)
Sakaide-Ayauta Area Association of School Nurses (July 24, 2015)
Initial response training
First-aid and basic life support training

附錄 2 (續)

Training session example (3/3)

Kagawa Prefectural School for the Visually Impaired (August 3, 2015)

- Initial response training and an evacuation drill were implemented.

Initial response training

Evacuation drill

Effectiveness of our training and Future works

1. Evaluation of the reproduction of disaster situations
   - The training simulator was able to reproduce the disaster situations. One trainee said that "I gave the children wrong evacuation instructions", which means that early warning for the earthquake was indicated, the trainee playing the teacher's role told the students, "take cover over the desk" rather than "take cover under the desk". He was upset and was unable to give appropriate instructions.
   - This indicates the difficulties that may be faced in a tense disaster situation. The disaster situation reproductions were also evaluated in opinion 5.

2. Evaluation of new information obtained from the training
   - The training system could provide new information to trainees. One trainee said that "It was much more difficult than I thought for a teacher to evacuate students properly." It seems that trainees were able to gain new information through the actual experience.
   - The training was performed two times. It was observed that the trainees were more active in the second session. During the second session, a trainee playing a student's roles fell down deliberately in the hallway scene, so the trainee playing the teacher's role was required to help the student, indicating that the trainees were able to predict unexpected situations as they became familiar with the possible scenarios.

附錄 3、四國危機管理教育研討會資料

附錄 3 (續)

～アクセスマップ～

香川大学林町キャンパス(工学部)

〒761-0396

香川県高松市林町2217-20

【交通アクセス】
公共交通機関(JR高松駅より)

◆ことでんバス【65レインボー経由フジグラン十川行】「香川大学工学部前」下車

◆ことでん琴平線「太田駅」で下車

◇太田駅よりバスの場合
【太田駅サンメッセ線】「香川大学工学部前」下車

◇太田駅よりタクシーの場合約8分

◇太田駅より徒歩の場合約30分

高速道路

◆高松中央IC(高松自動車道)より車で約5分

◆タクシー

・JR高松駅タクシー乗り場より 約30分

※ご来場は公共交通機関をご利用ください。

〆切 4月12日(水)
※当日参加も可能です。

お問い合せ

香川大学四国危機管理教育・研究・地域連携推進機構 企画調整室
〒761-0396 香川県高松市林町2217-20
TEL 087-864-2544 FAX 087-864-2549
E-mail kikikanri@jim.ao.kagawa-u.ac.jp

シンポジウム参加申込書

お申し込みの際は、下記の申込書に必要事項をご記入のうえ、FaxまたはE-mailにてご連絡くださいますようお願いします。
ご記入いただく個人情報につきましては、今回のシンポジウムでのみ使用し、これ以外の目的で利用することはありません。

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附錄 3 (續)

Earthquake Monitoring of Taiwan

Peih-Lin Leu, Mei-Yi Ho
Seismological Center, Central Weather Bureau, Taiwan

Taiwan is located along the boundary between the Philippine Sea plate and the Eurasian plate, one of the most active plate boundaries in the world. The two plates collide with each other in an oblique way, so most of Taiwan is under the northwest–southeast compression with a convergent rate about 8 cm/yr. Because this oblique collision between these two plates drives the mountain building and high seismicity in this area.

In the past hundred years, Taiwan had suffered by many destructive earthquakes. The latest 2 impressing and causing major casualty earthquakes in the last 20 years are the 1999 Chi-Chi earthquake with M_L 7.3 in the middle of Taiwan, and the M_L 6.6, Feb 06, 2016, Meinong Earthquake in southern Taiwan. That's why the earthquake monitoring and rapid releasing the information to public is a very important task to us.

The main tasks of Seismological Center including 1) Earthquake Rapid Reporting, 2) Earthquake Early Warning, 3) Tsunami Information Releasing, 4) Volcano Earthquake Monitoring, and 5) Earthquake Precursor Study.

For strong and potentially causing damage earthquake, to locate and distribute source information to the public in shortest time, so the public can take appropriate actions to avoid possible disasters is the main spirit of earthquake early warning. We have developed Earthquake Early Warning system over 15 years and officially put into the operational procedure, since 2014.

Today, our capability is to determine source parameters in about 15 ~ 20 seconds after earthquake occurrence, depends on how large is and the location and depth of earthquakes.

To improve the accuracy and efficiency of CWB's earthquake monitoring, the ongoing improvements include:

1. Increasing density of network and enhancing signal quality, such as Installation of borehole stations.
2. Expanding network coverage, such as installing Marine Cable Hosted Observatory, OBS.
3. Increasing signal resolution, such as upgrading the seismometers from 12/16 bits to 24 bits.
4. Improving the auto-processing modulus.

附錄 3 (續)

台湾における地震モニタリング

Peih-Lin Leu, Mei-Yi Ho
台湾中央気象局（CWB）　地震センター

台湾は世界でも有数な活発なプレート境界である、フィリピン海プレートとユーラシアプレート境界に位置している。この 2 つのプレートは年 8cm の速度で斜め衝突帯を形成しており、台湾は北西—南東方向の圧縮場にある。
この斜め沈み衝突帯が山地を形成し、活発な地震活動帯を形成している。

過去 100 年間で、台湾では多くの被害地震が発生している。過去 20 年における代表的な被害地震としては、台湾中部で発生した 1999 年集集地震(M7.3)、台湾南部の 2016 年 2 月 6 日の美濃地震（M6.6）が挙げられる。このことが、我々が地震をモニタリングする理由であり、一般向けに即時地動情報を提供することは我々の重要な使命である。

台湾中央気象局（CWB）地震センターの重要なミッションは、即時地震情報提供、緊急地震速報、津波情報、火山性地震監視ならびに地震前兆研究である。
被害地震に対して、迅速に震源、震源分布情報を公表することで、人々が被害軽減に向けた適切な行動を可能とすることからも緊急地震速報が重要である。
CWB 地震センターは、これまで 15 年以上緊急地震速報システムを研究開発し、2014 年より運用を開始した。

今日では、CWB 地震センターはその地震規模や深さならびに発生場所にもよるが、地震発生後約 15 秒から 20 秒以内で、震源パラメータを決定することが可能である。今後 CWB 地震センターの地震モニタリング機能向上のためには、以下のような機能向上が必要である。

1．観測網密度の向上や坑内計測のような高品質なデータ
2．海域観測網の展開といった観測範囲の拡大
3．24 ビットの高分解能な観測データ品質向上
4．自動処理システム

附錄 3 (續)

Reconstructing the historical earthquakes in Taiwan based on historical documents

Cheng, Shih-Nan
Department of Applied Geomatics, Digitial Earth and Disaster Reduction Research Center,
Chien Hsin University of Science and Technology

Abstract

The literatures and seismograms of historical earthquakes are recompiled, to establish the database of historical earthquake in Taiwan. The results will serve as the study of seismic activity, plate tectonics, assessment of earthquake disaster and earthquake history. The data of historical earthquakes includes two parts: one is the literature and archives, another is seismogram received by seismograph. Historical earthquake documents and archives are divided into the following four categories: 1) official version of the file, 2) the local version of the literature, 3) personal records and article, and 4) temple history and stele. The seismic records are divided into four categories: original seismogram, copy of seismogram, microfilm of seismogram, and text description records. Consider the data processing and storage space, image files to replace the microfilm to store seismic records. The earliest original seismogram was recorded by the Omori seismograph for Tainan station on March 1, 1902. The earliest copy seismogram was recorded by the Gray-Milne seismograph for Tainan station on June 29, 1900. The preliminary results are compiled as a Web page, the future will be regularly updated subsequent processing results.

According to the descriptions of disaster to estimate the corresponding intensity. The GIS tool is used to build the distribution of disasters and intensities. Refer to the distributions of disaster and intensity, the active fault map, the geophysical and geological observation data, the present seismic activity, to estimate the possible source parameters. The empirical formula of acceleration attenuation law is used to simulate isoseismal map. By simulate isoseismal map and observed intensity distribution of historical event are compared to assess the reasonableness of the source parameters. The disasters earthquakes caused more than 100 deaths as the main objective, including the 1736 Tainan earthquake, the 1792 Chiayi earthquake, the 1815 Ilan earthquake, the 1839 Chiayi earthquake, the 1845 Taichung earthquake, the 1848 Changhua earthquake, and the 1867 Keelung earthquake.

附錄 3 (續)

過去の文献と記録に基づく台湾の歴史地震情報の再構築

Cheng, Shih-Nan

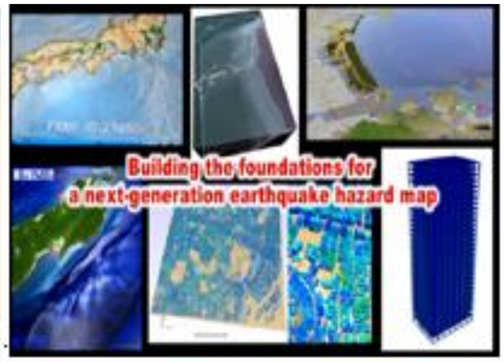
健行科技大学

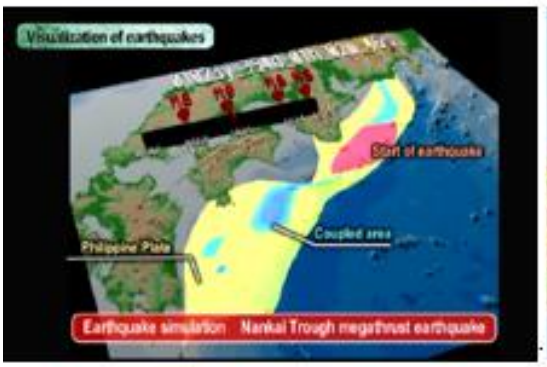
台湾の歴史地震データベースを構築するために、歴史地震に関する古文書や過去の記録が再編集されている。この結果は台湾の地震活動、プレートテクトニクス、地震災害ならびに歴史地震の評価に活用されている。
歴史地震のデータは 2 つの部分に分かれている。その 1 つは古文書や保管された情報で知る。もう一つは過去の歴史地震波形記録である。
過去の地震に関する古文書や保管情報は以下の 4 つに分類されている。1 つ目は公的ファイル、2 つ目は地方の古文書、3 つ目は個人情報や記述、4 つ目は寺院の歴史や石碑である。過去の地震記録においても 4 つに区分されている。
原記録、コピー記録、マイクロフィルム記録ならびにテキスト記載記録である。
データ処理と保管スペースを考慮すると、地震記録に保管されるものは、イメージファイルをマイクロフィルムに変換されるべきである。
台湾における初期の原地震波形記録は 1902 年 3 月 1 日に観測所設置された大森式地震計によって記録されたものである。コピー記録は 1900 年 6 月 29 日に設置されたグレイ—ミルン式地震計によるものである。予備的な結果として編集されたデータベースはウェブページに記載され、将来的には、データ解析結果として継続的に更新される。

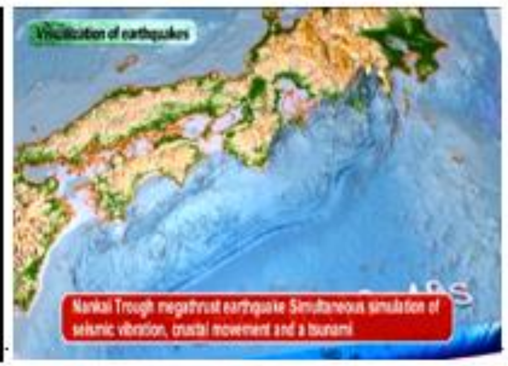
被害の記載を行う際には、ＧＩＳは災害と地震動の記載をするために有効である。また、可能性のある地震パラメータを評価するためには、被害と地震動、活断層ならびに地球物理や地質学的な観測データの分布ならびに現在の地震活動を用いるべきである。等震度線を想定するためには経験的な加速度減衰式が用いられる。想定された等震度線と過去の歴史地震の観測データ分布の比較により可能な地震パラメータ評価が行われる。
被害地震では主として 1736 年の台南の地震、1792 年嘉義地震、1815 年宜蘭地震、1839 年嘉義地震、1845 年台中地震、1848 年彰化地震、1867 年基隆地震といったものがあり、100 人以上の犠牲者が発生している。

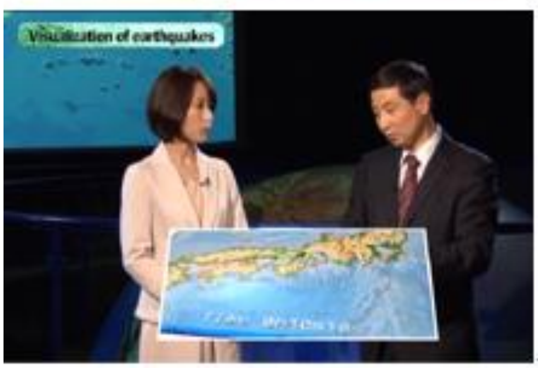
六、攜回資料

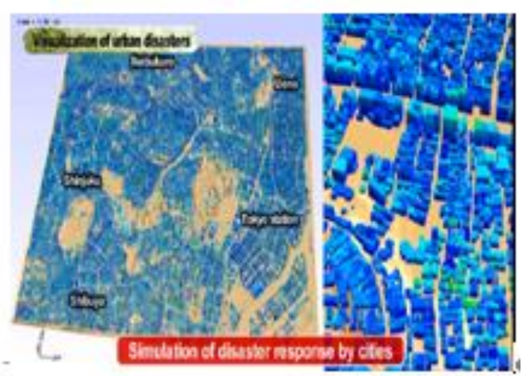
(一) JAMSTEC DVD 片及部份影片內容截取











(二) 金田義行教授撰寫的科普書籍

(三) 小豆島地質考察資料

小豆島巡検(12:35土庄港行きパターン)
Field Trip to Shodoshima

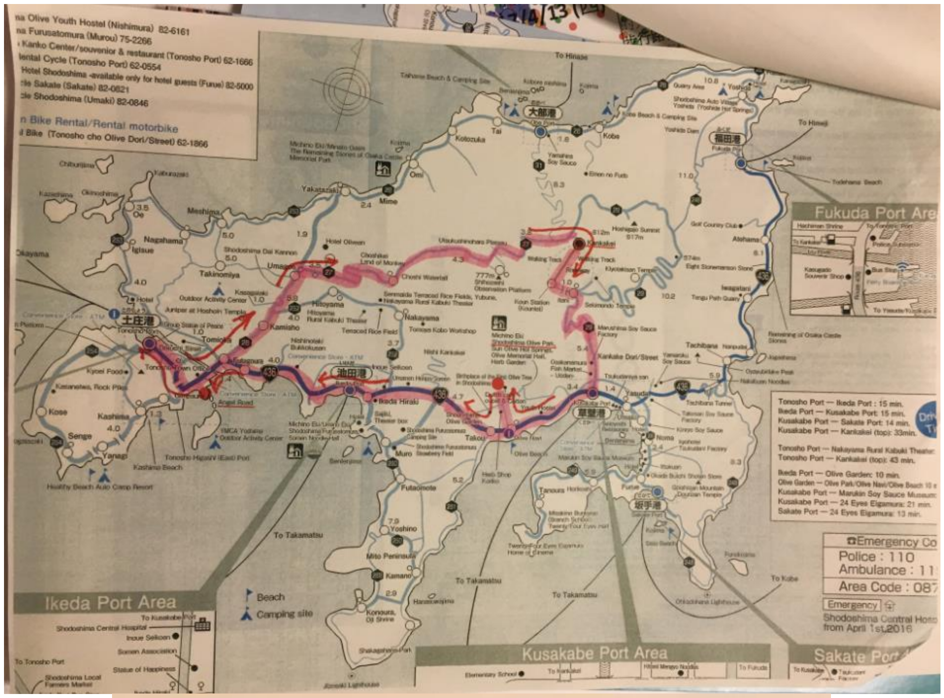
1. 日 時　平成29年4月12日（水）
Date: April 12 (Wed.), 2017

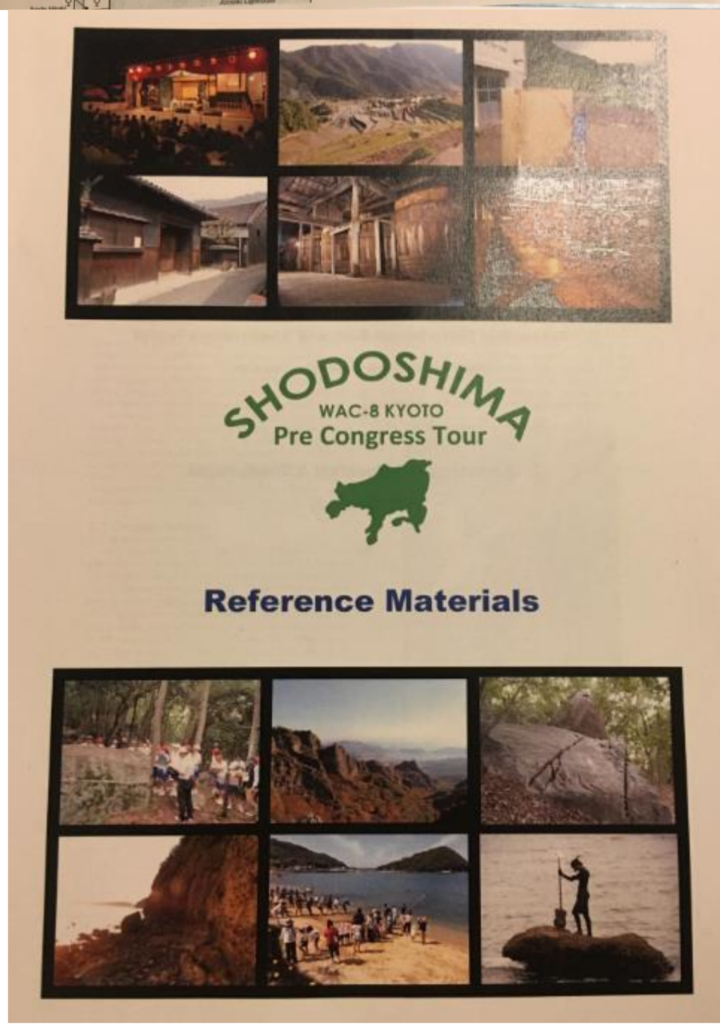
2. 巡検先、訪問先 Visit Places

・小豆島町　寒霞渓他 Kankakei and etc.

	行　　程 Itinerary	各地発着 Departure(D) and Arrival(A)	備　　考 Note
	三宮バスターミナル Kobe-sannomiya bus terminal	09:05発(D)	神姫バス(神戸三宮→高松) 3,700円 Shinki Bus from Tobe-sannomiya to Takamatsu 3,700JPY
	ゆめタウン高松(下車) Yume-town Takamatsu	11:42着(A) 11:45発(D)	公用車(セレナ)乗り換え Picking up by car
	高松港(土庄港行き)フェリー Takamatsu port Ferryboat toTonosho port	11:55着(A) 12:35発(D)	1,320円(往復) 1,320JPY per person (round trip)
	【乗船後フェリー内にて、昼食】 Lunch in the boat	60分	
	土庄港 Tonosho port	13:35着(A) 同　発(D)	
	寒霞渓ロープウェイ、山頂駅 Kankakei ropeway, Summit Station	14:10着(A)	Arrival at Summit Station, Kankakei by car Stay here about 10-20min
	〃　　、こううん駅 Kankakei ropeway, Koun Station	約5分 Apprx. 5 min ride	毎時、12分間隔で運行 810円 Ropeway Operation: Every 12 min. 810JPY per person
	こううん駅 Koun Station	14:35発(D)	こううん駅にて公用車に乗り換え Picking up by car at Koun Station
3/12(水)	道の駅　小豆島オリーブ公園 Michino Eki, Shodoshima Olive Park	14:55着(A)	
	【休　憩】 Rest (Free time)	60分	
	道の駅　小豆島オリーブ公園 Michino Eki, Shodoshima Olive Park	15:55発(D)	
	エンジェルロード公園 Angel Road Park	16:15着(A)	
	【休　憩】 Rest (Free time)	40分	干潮時刻18:10(前後2時間は渡れる) Time of low tide: 18:10 (We can walke across the sea between 16:10-20:10)
	エンジェルロード公園 Angel Road Park	16:55発(D)	
	土庄港(高松行き)フェリー Tonosho port Ferryboat to Takamatsu port	17:05着(A) 17:30発(D)	
	高松港 Takamatsu port	18:35着(A) 同　発(D)	
	ダイワロイネットH高松 Daiwa Roynet Hotel Takamatsu	18:45着(A)	Check-in

※ フェリー(土庄発→高松港):17:30、18:40
高速艇(土庄発→高松港):17:50(最終便) 1,170円


Ikeda Port Area
Kusakabe Port Area
Fukuda Port Area
Beach
Camping site
Police : 110


SHODOSHIMA
WAC-8 KYOTO
Pre Congress Tour
Reference Materials

Subaqueous Volcanism and Mantle-Derived Andesites on Shodo-Shima Island

Y. Tatsumi
Ocean-Bottom Exploration Center, Kobe University

Although Shodo-Shima Island, located in the eastern part of the Seto Inland Sea, to the northeast of Shikoku Island, is a small island (~153 km²), it has attracted earth scientists significantly over the past two decades because of the occurrence of 'high-Mg andesites (HMAs)'. HMAs are distinct from normal andesites in their elevated MgO contents and may represent magmas derived directly from the Earth's upper mantle with little intra-crustal compositional modification. This unique magma was produced under unusually higher temperature conditions in association with a mega-tectonic event at ~15 million years ago including break-up of the eastern margin of the Asian continent, drift of Japanese Islands from the continent, and creation of the Japan Sea behind the islands.

1. Introduction

The Earth is unique in our solar system in having buoyant, highland-forming continental crust with a differentiated, andesitic composition; thus it can be referred to as an 'andesite planet.' Andesitic magmatism typifies convergent plate margins such as subduction zones, leading to a broad consensus that this setting has been the major site of continental crust formation.

Although HMAs are volumetrically rare on the modern Earth, understanding of the origin of HMAs should provide a key to decoding fractionation processes in the solid Earth. The reason for believing so is that the bulk continental crust, a geochemical reservoir highly enriched in light elements, possesses a composition similar to HMA and hence HMAs could have been a major product in the early Earth.

2. Geologic Setting

2.1 *Setouchi volcanic belt*

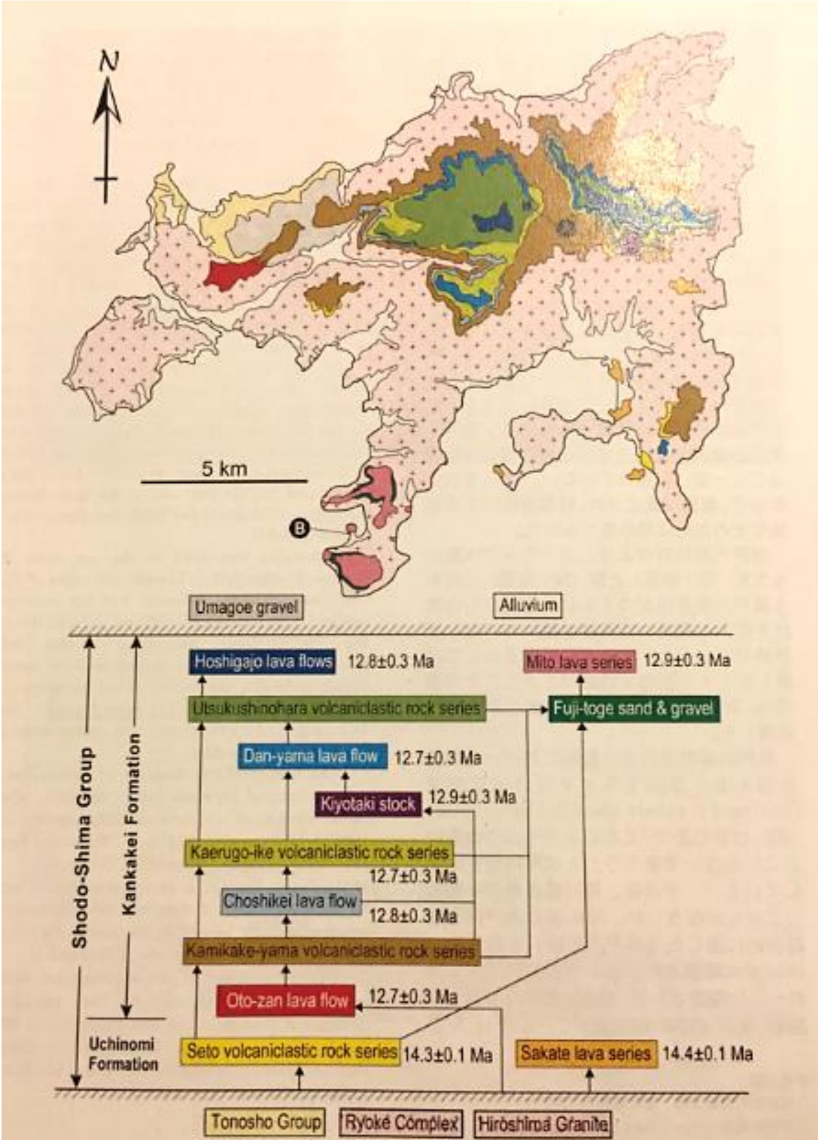
The current SW Japan arc has, and continues to be generated by subduction of the Philippine Sea Plate at the Nankai Trough beneath the Eurasian Plate (Fig. 1). The Quaternary volcanic front is located ~100 km above the top of the subducting lithosphere, in common with most arc-trench systems. Miocene igneous rocks are found in the present fore-arc region of the SW Japan arc. In the near-trench region of this arc (the Outer Zone), i.e., to the south of the Median Tectonic Line (M.T.L. in Fig. 1), felsic volcanic-plutonic complexes were emplaced at 14±1Ma into a Cretaceous to Miocene accretionary prism or subduction complex (Fig. 1).

Synchronous with this near-trench magmatism, volcanism took place in the Setouchi volcanic belt (SVB) at 13.7±1.0 Ma, across ~600 km in five major volcanic regions, from west to east: NE Kyushu, NW and NE Shikoku, Osaka, and Shitara (Fig. 1). SVB is characterized by the occurrence of volcanic rocks such as pitchstone, garnet-bearing dacite, and phenocryst-poor, sparsely plagioclase-phyric andesites and basalts, referred to as sanukites or sanukitoids: 'Sanuki' is the old name of the NE Shikoku region.

The Shikoku Basin, situated to the south of the SW Japan arc (Fig. 1), is a back-arc basin that was created behind the Izu-Bonin-Mariana arc, by rifting from 30 to 15 Ma, leaving the Kyushu-Palau ridge as a remnant arc (Fig. 2).

The Sea of Japan, which is situated behind the SW and NE Japan arcs (Fig. 1), is also a back-arc basin and formed as a result of rifting of the eastern margin of the Asian continent at the same age as the Shikoku Basin formed (Fig. 2). The opening of this back-arc basin caused clockwise and counterclockwise rotations of the SW and NE Japan arc slivers, respectively, at ~15 Ma, which resulted in the subduction of the young (<15 m.y.) oceanic lithosphere of the Shikoku Basin beneath the SW Japan arc. Back-arc basin formation results in or is caused by upwelling of asthenospheric material that

Fig. 1. Distribution and tectonic setting of the Setouchi volcanic belt (SVB). The SVB is located in the fore-arc region between the Quaternary volcanic front and the Nankai Trough in the SW Japan arc and has the five major volcanic regions: 1, NE Kyushu; 2, NW Shikoku; 3, NE Shikoku; 4, Osaka; 5, Shitara. In the near-trench region of this arc (the Outer Zone), i.e., to the south of the Median Tectonic Line (M.T.L.), felsic volcanic-plutonic complexes were emplaced simultaneously with SVB.



Appendix. Geological map and geological relationships of Shodo-Shima Island. The identical color is used for a geological unit in both diagrams. K-Ar ages in the lower diagram. A and B are visiting sites.

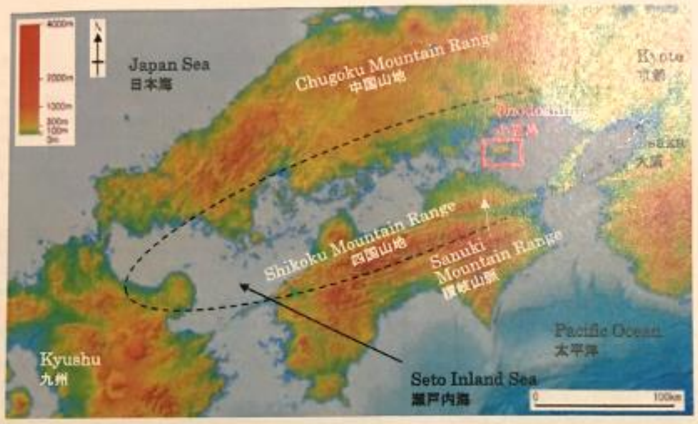


Fig. 1.1 Topographic map of Setonaikai
瀬戸内海の地形 [2]

Fig. 1.2 Area of Setonaikai National Park
瀬戸内海国立公園の範囲 [4]

Fig. 1.3 Bathymetry of Setonaikai
瀬戸内海の海底地形 [2]

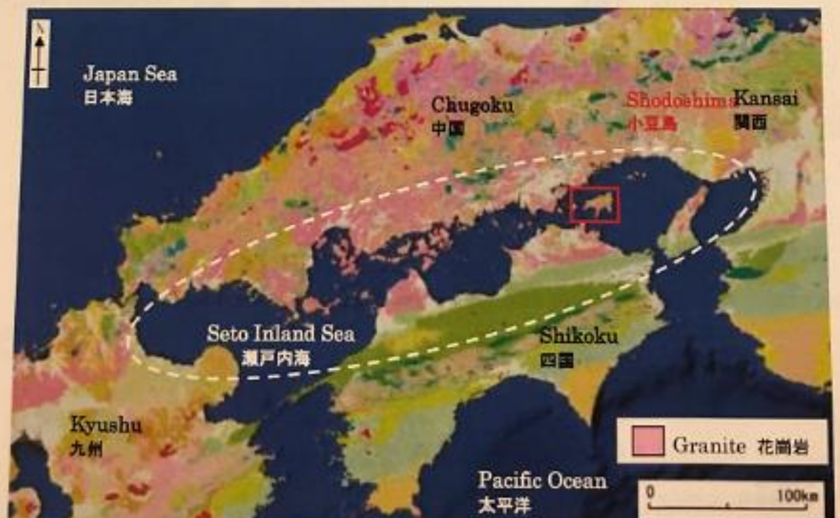


Fig.1.4 Geological map of Setonaikai
瀬戸内海の地質 [1]

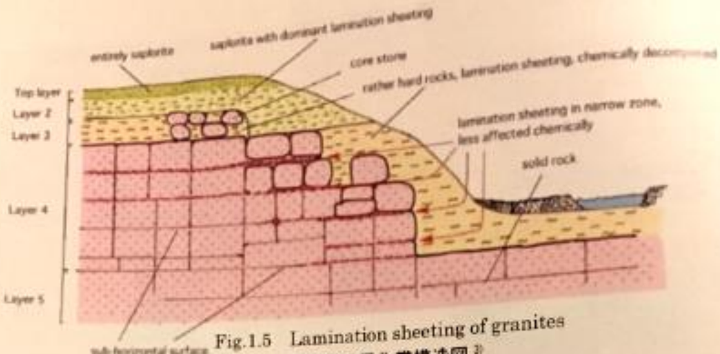
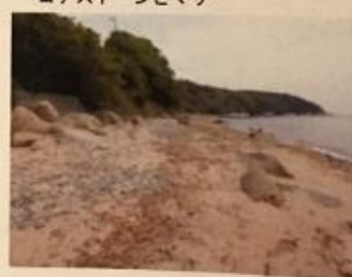


Fig.1.5 Lamination sheeting of granites
花崗岩の風化帯構造図 [3)]

①Granite 花崗岩

②Corestone and "masa" (decomposed granite)
コアストーンとマサ

③Tor (Yoshida, Shodoshima town)
トア（小豆島町吉田ダム）



④ "Masa" (decomposed granite) and "grey stones" (setouchi volcanic rocks) in beach (Iwagatani, Shodoshima town)
花崗岩のマサ由来の砂浜と瀬戸内
火山岩由来の灰色岩塊（小豆島町岩谷）

Fig. 1.6 Geolandscape of Seto Inland Sea
地質と景観がおりなす瀬戸内海の景観

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1) 環境省ホームページ：「瀬戸内海の環境情報」,
https://www.env.go.jp/water/heisa/heisa_net/setouchiNet/seto/kankyojoho/image/zu1-03.gif
2) Seamless Digital Geological Map of Japan ; https://gbank.gsj.jp/seamless/index_en.html?
3) 藤田勝代, 横山俊治：香川県小豆島の花崗岩のラミネーションシーティングと小豆島石を訪ねて, 地質学雑誌 Vol15, 補遺, pp. 89-107, 2009.

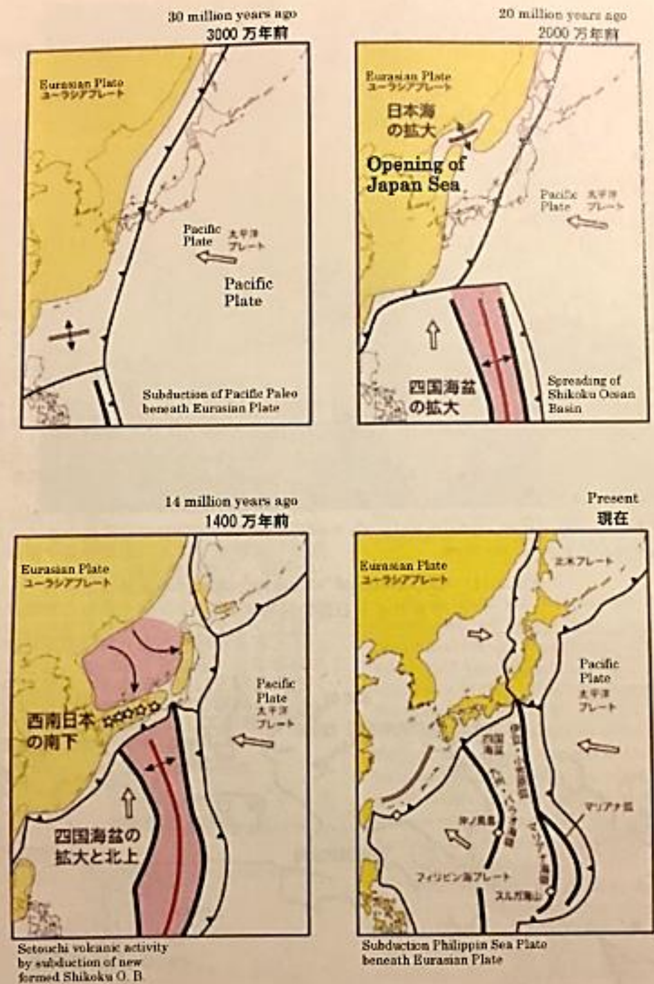

Fig.1.10 Movement of the plates around Japan
日本列島の変遷 [1]

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1) 巽好幸：なぜ世界のマグマ研究者が小豆島に注目するのか, 小豆島石の魅力創造シンポジウム資料集, 2013.

● Remains that yielded sanukaite tools △ Area that produced sanukite tools
▲ Area that produced obsidaian

Fig.1.11 Dipersion of "sanukite" stone tools
サヌカイト石器の分布 1)

Fig.1.12 "Setonaikai" in the Post Glacial Age(10,000 ys ago)
後氷期（約 1 万年前）時代の瀬戸内海 2)

参考文献
1) 産総研地質調査総合センターホームページ：https://www.gsj.jp/event/images/johoten2009/11-03_02.jpg.
2) 柳哲雄：瀬戸内海はどのような海か, 学術の動向, 2008

Fig.2.1 Topography of Shodoshima Island
小豆島の地形 [1]

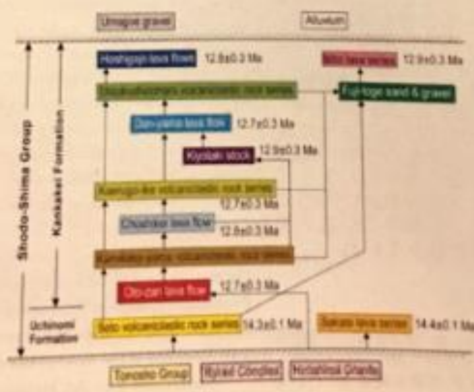

Fig.2.2 Schematic geologic profile of Shodoshima Island
小豆島の模式地質断面図 [2]