地質調查所報告

第百十四號

地質調査所報告　第百十四號　昭和七年十二月

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（昭和七年六月稿）

商工技師　植村癸巳男

昭和六年十二月初旬ヨリ大阪府中河内郡堅上村字峠部落附近ヲ中心トシテ徐々ニ地辷運動開始セラレ、其ノ結果地表ノ地割レ、民家ノ倒潰ハ勿論、關西本線龜ノ瀬隧道ノ崩壊、不通、大和川河床及對岸奈良縣々道面ノ隆起等ヲ惹起シ多大ノ被害ヲ及ホセリ　因テ依命昭和七年二月二十三日ヨリ同二十八日迄現地ニ出張シ之カ調査ニ從事シタリ　乃チ玆ニ其結果ヲ報告ス

附圖ハ調査ニ同行シタル商工技手小松直藏ノ新ニ測量製圖シタルモノニシテ測量原圖ノ縮尺ハ二千分ノ一ナリ　而シテ同圖上ニ示セル龜裂及陷沒等ハ地辷運動ノ尙終熄セサリシ調査當時ニ於テ現存シタルモノヽミノ狀態ヲ示スモノナリ

一、地形及環境

變災地ノ位置及地形　地災ハ奈良盆地ト河內平野トヲ東西ニ境スル生駒、葛城山脈中ニ於

テ、同山脈ヲ横斷シテ西流スル大和川峽谷内ニ起リタルモノニシテ、其區域ノ大部分ハ大和川ノ北岸ニ在リテ大阪府中河内郡堅上村字峠ニ屬シ、其餘波ハ大和川ヲ越エテ南岸ノ奈良縣北葛城郡王寺町字藤井ノ地域ニ及ヘリ

變災地附近ノ地形ハ大和川ヲ隔テヽ其南北ニ於テ大ニ趣ヲ異ニセリ　即チ北側ハ峠部落ノ北々西八百米ヲ隔テタル「とめしよ」山(海拔二七六・四米)及更ニ其北々西六百米ヲ隔テタル「どろころ」山(海拔三一二・九米)ノ二小火山ヲ附近ニ於ケル最高頂トシ、夫レヨリ東方及ヒ大和川(河床海拔三二・〇米)ニ向ヒテ南及南東方ニ緩斜シ、峠部落ハ其南向斜面上ニ在リ　而シテ該斜面ハ略海拔百五十米等高線ノ通過スル附近ニ於テ急ニ斜度ヲ變シ其南部即今回地災ノ起リタル峠部落ヲ中心トスル地域ハ傾斜緩ニシテ臺地狀ヲ呈ス　此臺地狀緩斜地ハ比較的規則正シク南東方ニ緩斜セルモ峠部落ヲ通過シ龜ノ瀨東西兩假驛ヲ連ヌル道路ニ沿ヘル淺キ谷ヲ界トシテ其以南ノ地ハ再ヒ緩慢ニ隆起シ、稻葉及南平ノ小丘ヲ成シ、此小丘ノ南側ハ大和川ニ向ツテ斜下シ、其北岸ニ於テ高距三十乃至四十五米ノ急崖ヲ成シテ終レリ

大和川ノ南側ハ二上火山ノ北端ヲ成セル明神山(海拔二七四・九米)ノ急峻ナル北斜面ニシテ、北側ニ於ケル緩斜地形ト著シキ對照ヲ成ス　京大槇山敎授ハ該地形ヲ以テ大和川ニ沿ヒテ東西ニ走レル斷層ニ因ルモノトセリ

大和川ハ奈良盆地ノ水ヲ集メ變災地ノ東、王寺町藤井部落附近ニ至ルヤ生駒葛城山脈ニ會シ爲ニ兩岸ノ山脚急ニ迫リテ峽谷狀ノ横谷トナリ、峠部落ノ南西龜ノ瀨隧道西口ノ直南ニ於テハ古來有名ナル龜ノ瀨岩累々トシテ河床ニ露出シ玆ニ急湍ヲ爲セリ

峠部落附近ノ環境　峠部落ハ人家二十四、人口百八十ノ小部落ナルモ、附近ノ緩斜地ハ南面シテ比較的溫暖ナルト區域内ノ安山岩カ粘土化シテ肥沃ナル土壤トナレル事ニ依リテ本地方有數ノ果樹―主トシテ葡萄及桃其他蜜柑―栽培地トシテ名アリ　從ツテ峠附近ノ臺地狀緩斜地ハ勿論、「とめしよ」高地方面ニ至ル地域迄略等高線ニ沿ヘル多數ノ階段ヲ設ケテ果樹園トシテ利用セラルヽ外、海拔略百二十米以下ノ峠附近ノ臺地狀緩斜地ハ又水田トシテ利用セラル　本地方ノ森林ヲ拓キ、階段ヲ設置シテ前述ノ如ク利用シ始メタルハ近年ノ事ニ屬シ、水田ノ如キハ明治三十年以後ヨリ漸次其面積ヲ增加シテ今日ニ至レルモノナリト云フ　本地域内ニハ水田灌漑用ニ利用スヘキ地表水ニ乏シキ爲メ「とめしよ」小火山南斜面カ斜度ヲ變スル處即海拔百二十米内外ノ等高線ニ沿ヘル地帶、特ニ夫婦塚方面ニ多數ノ貯水池アリ

龜ノ瀨隧道　關西本線ハ大和川北岸ニ沿ヒテ敷設セラレ、變災地下ヲ所謂龜ノ瀨隧道ニ依リテ通過セリ　龜ノ瀨隧道ハ王寺、河内堅上驛間、名古屋起點一五二粁二八一ニ在リ　隧道ノ延長ハ七〇三米四四、勾配千分ノ十、上リ及水平曲線半徑四〇〇米及直線ナリトス

本隧道ハ初メ元大阪鐵道株式會社ニ依リ開鑿セラレタル單線隧道ニシテ、當時ノ隧道西口ハ現位置ナルモ東口ハ大和川ノ北岸川ノ上ニ開口セラレ隧道ハ稻葉丘ノ南東ヲ川ニ沿ヒテ迂廻セリ　其後國有鐵道トナリ複線計畫就ルヤ、大正十二年十二月峠部落下ヲ通過スル現今ノ上リ線隧道增設セラレ、次テ既設隧道ノ東半部廢棄セラレ、更ニ上リ線ト並行スル新隧道開鑿セラレ下リ線トシテ使用シ以テ今日ニ至レリ

龜瀨隧道(上下兩線)ハ以上ノ如キ經路ヲ取リタル爲メ左表ノ如ク其大サ及構造ニ於テ異リ、上リ線隧道ハ下リ線隧道ニ比シテ優レリ

	幅員	高サ	構造
上リ線隧道	十六呎	十八呎三吋	「コンクリート」、一部煉瓦卷
下リ線隧道	十四呎	十四呎	煉瓦卷

奈良、大阪線縣道　大和川南岸即奈良縣側ニ於テハ昨年來大和川ニ沿ヒテ明神山ノ急峻ナル山脚ヲ切リ取リ、既設奈良、大阪線縣道改修中ニシテ、本年六月中ニハ完成ノ豫定ナリシモ、地災ノ爲メ垂直移動著シク、使用ニ堪エサルニ至レリ

二、地　　災

變災地ノ廣袤及形狀　變災地ハ略楕圓形ヲナシ、北東ヨリ南西ニ六百五十米、北西ヨリ南東ニ五百四十米ノ幅員ヲ有シ、面積約三十二「ヘクタール」ニシテ、其ノ東、西及南ノ外廓ハ比較的規則ニ正シキ曲線ヲ成スモ、北西部ニ於ケル外廓ハ南東方ニ向ヒテ開口セル四個ノ半圓又ハ馬蹄形ノ龜裂、北東ヨリ南西ニ並列シ、全體トシテ外廓線ハ波狀ヲ呈セリ

龜　裂　本地災ノ初メテ人目ニ觸レシハ昭和六年十一月二十七日、峠部落ノ北西、夫婦塚附近ニ發生シタル小龜裂ナリトス　該龜裂ハ日ヲ經ルニ隨ヒ、幅員ヲ增大スルト共ニ、是ヲ中心シトテ其東、西及南方ニ漸移擴大シ、一月初旬中ニハ既ニ變災地ノ外廓ヲ成セル大龜裂及峠部落ヲ橫切ル二條ノ主要龜裂等略生成シ、一月中旬ニ入ルヤ地辷運動ノ餘波ハ變災地ノ東部及南部ニ及ヒ、地盤ノ隆起及之ニ伴フ龜裂ノ發生ヲ見タリ

以上ノ龜裂發生ノ經過ヲ更ニ詳述スレハ、昭和六年十一月二十七日峠部落民カ部落ノ北西方夫婦塚直東ノ乾田中ニ、北東ヨリ南西ニ走ル幅員〇・一米內外ノ龜裂二條ヲ發見シタルヲ以テ、地災現象ヲ認知シタル最初トナス　本龜裂ハ漸次其幅員ヲ擴大スルト同時ニ、十二月八日其西方雁多尾畑ニ至ル道路附近ニ、又同月十日ニハ夫婦塚ノ東方既存龜裂ニ接續シ更ニ其東

方ニ、新龜裂生セリ　十二月二十日ニハ既存龜裂幅員益々擴大セラルヽト共ニ、其東西兩端ヨリ東方及南方ニ向ヒ新龜裂多數連續發生シ、十二月二十二日ニハ夫婦塚ヨリ佛生堂ヲ過キ南下シ來レル龜裂ハ龜瀨隧道西口ノ東方ニ及ヘリ　十二月二十八日ニハ峠部落東部ニ北東ヨリ南西ニ走ル龜裂發生シ、該龜裂ハ階段斷層ノ如キ地辷運動ヲナシタル爲メ、該龜裂線上ノ民家ニ在リテハ戸障子ノ開閉困難トナリ、日ヲ經ルニ隨ヒ家屋ノ傾斜甚シク、倒潰ニ瀕スルモノ續出セリ　一月二日佛生堂南部、峠部落ノ直西ニ於ケル既存龜裂ノ東方ニ之ト並行セル新龜裂、一月五日ニハ市ヶ平ヲ圍繞スル龜裂、翌三日ニハ峠部落ノ中央ヨリ南部ニ走ル龜裂生シ、同八日ニハ峠部落ノ東端ニ於ケル既存龜裂ハ更ニ東方ニ向ヒテ擴大セリ　一月中旬ニ入ルヤ地辷運動ノ餘波ハ變災地南部及東部ニ土地ノ隆起或ハ其前兆トシテ鼬道隆起ヲ生シ、一月十九日大和川南岸奈良大阪線縣道面ニ發見セラレタル數條ノ龜裂ハ同二十三日ニハ無數ノ小龜裂ト數ケ所ノ膨レ上リトナリ、以來該縣道面ハ隆起ヲ繼續シ、四月十日迄ニハ最大八米八餘ノ隆起ヲ示セリ

調査當時ニ於テ隆起セル土地ノ範圍ハ變災地ノ東緣ヲ成セル長尾ノ東部山麓ヨリ鐵道線路ヲ横切リテ南方大和川河床ニ及ヒ、玆ニ新ニ現出シタル中洲トナリ、更ニ大和川ノ北岸舊鐵道線路ニ沿ヒテ、舊隧道口附近ニ亙リ、南ハ大和川ヲ越エテ對岸ニ達シ、奈良大阪線縣道面ニ著

シキ隆起現象ヲ示セリ　但シ隆起ハ此處ニ止マリ其以外ニハ及ハサルモノヽ如シ

一月二十日南平東方(俚稱川ノ上)舊隧道口ノ周圍ニ龜裂生シ、同二十四日降雨後二十五日夕方大和川北岸「おわんかけ」ノ急崖ハ樹木ヲ戴セタルマヽ河中ニ崩壞シ、同日同處ノ北東、南平ノ墓地ニ龜裂發生セリ

龜ノ瀨隧道ノ被害　龜ノ瀨隧道內壁ニ龜裂ヲ見出シタルハ既ニ昭和六年十一月三十日ニシテ、以後日ヲ經ルニ從ヒ其數及幅員增大シ、內壁ノ胎ミ出シ或ハ脫落箇所續出シ、一月中旬ニハ隧道ノ中心ハ大和川ニ向ヒテ約六糎移動セリ　一月二十日、最モ危險ヲ感シタル隧道西口ヨリ八十米ノ地點附近ニ約二十米ノ間「レール、センター」補强工事ヲ施シテ地壓ヲ防止セント試ミタルモ、隧道ノ移動ハ止ラス、下リ線隧道ノ車輛限界ハ益々減少スル爲、同月二十二日下リ線ノ使用ヲ中止シ、上リ線ニ依ル單線運轉ヲ開始セリ　如斯關西本線ノ運轉系統ハ辛ウシテ保持セラレタルモ、隧道內ノ危險ハ益々增加スルノミナリシヲ以テ、二月一日終ニ上リ線ノ使用モ中止シ、隧道ノ東西兩口ニ假驛ヲ設ケテ徒步連絡ヲ開始シ、茲ニ關西本線ノ運轉系統ハ全ク中斷セラルヽニ至レリ　二月四日下リ線西口ヨリ八十米ノ地點ニシテ佛生堂ヨリ南下シ來レル龜裂線ニ當レル隧道內ノ箇所ハ音響ト共ニ崩壞シ、同九日上リ線西口ヨリ百二十米ノ箇所又大崩壞ヲ來シ、翌十日、上下兩線共完全ニ崩壞セリ　峠部落ノ南ナル南平、稻葉丘間ノ谷及西

口東方徒歩連絡道路上ノ如ク隧道直上ノ被覆部淺キ部分ニ於テハ隧道ノ崩壞ニ伴ヒテ地表ニ直徑三米内外ノ陷落穿ヲ生セリ

龜裂ノ形及幅員　佛生堂南部桃畑内、夫婦塚直東部、市ノ平北部等ニ於ケル變災地ノ外廓ヲ成ス龜裂ニシテ地辷運動ノ方向ニ一致スルモノハ其附近ニ標式的ノ雁行龜裂ヲ伴ヘリ　佛生堂南部ニ於ケル雁行龜裂群ハ最モ顯著ナルモノニシテ調査當時ニ於テモ明瞭ニ現存セリ　夫婦塚東部ニ於ケルモノハ發生ノ時日早カリシ爲、調査當時ニ於テハ稍明瞭ヲ欠ケリ　佛生堂南部ニ於ケル雁行龜裂ヲ伴フ二並行龜裂内ノ地域ハ一乃至五米内外陷落シテ地溝ノ如キ地貌ヲ呈セリ　龜裂ノ幅員ハ日ヲ經ルニ隨ヒテ增大セラレ特ニ變災地ノ外廓ヲ成スモノニ於テ著シ　調査當時ニ於テハ夫婦塚東部龜裂ノ見懸ケ上ノ幅員ハ九米、同西部雁多尾畑ニ至ル道路上ニ於テハ三・五米ニ達セリ　是等ノ大ナル見懸ケ上ノ幅員ハ單一ナル龜裂ノ幅員ニアラスシテ主龜裂ニ斜行セル雁行龜裂群或ハ主龜裂ニ並行セル數條ノ龜裂カ一連トナリテ陷落シタル幅員ナリ　單一ノ龜裂ノ幅員ハ一米ヲ超ユルモノ少ク、一米以上ニ龜裂ノ幅員カ擴大セラルヽ場合ニハ必ス二個以上ノ龜裂合併シ、其結果トシテ一龜裂ノ幅員カ增大シタルカ如ク見ユルコト多シ

辷面ニ對スル考察　地災ニ對シ重大ナル因果關係ヲ有スル辷面ハ地表面ニ於ケル調査ノ

ミニ依リテハ其性狀ヲ知ル事困難ニニシテ、試錐其他ノ方法ニ依ラサルヘカラス　然レトモ本變災地ノ北西部外廓ヲ成ス龜裂ノ配置ト、本變災地ノ地形トヲ併セ考フル時ハ、地表ニ於テ直接之ヲ認知シ得サル辻面モ地形圖上ヨリ間接ニ之ヲ算出スルヲ得ヘシ

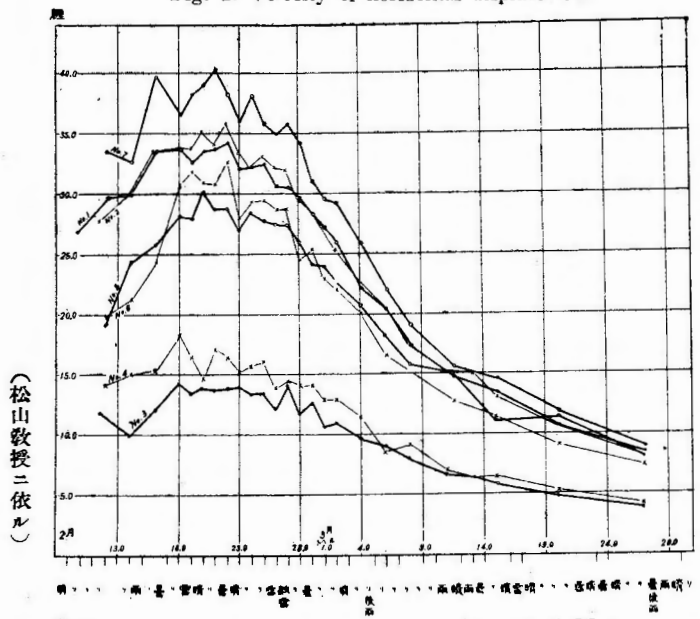
前述シタルカ如ク、本變災地ハ南方及南東方ニ緩斜セル臺地狀緩斜地ニシテ、略北々西ヨリ南々東ニ向ヒテ並走セル三條ノ凹谷ヲ伴ヘリ　又本變災地ノ北西部外廓ヲ成ス龜裂ハ南東方ニ向ヒテ開口セル四個ノ半圓又ハ馬蹄形龜裂カ、北東ヨリ南西ニ向ヒテ連續配列セルモノニシテ、大體トシテ波狀ヲ呈セリ　而シテ該波狀龜裂ノ頂部ハ常ニ地形上ノ高所ニ向ヒテ衝上シ、其兩側ハ凹谷部ニ向ヒテ斜ニ下リ、結局二半圓又ハ馬蹄形龜裂ノ接續部ハ必ス凹谷部ニ存セリ

如斯龜裂ノ配置ハ極メテ緩漫ニ南東方ニ傾斜セル辻面カ、同一方向ニ緩斜スル地表面ニ現出スル位置ヲ示スモノナルヘク、若シ然リトスレハ地形圖上ヨリ辻面ヲ算出スル時ハ、辻面ハ南東方ニ十五度以下ノ緩傾斜ヲ成スモノトナルヘシ

地盤ノ移動方向及速度　地盤ノ滑動方向ハ地表面ノ傾斜方向即略南五十度東ニシテ大和川峽谷ニ向ヘリ　其水平移動量ハ變災地內ノ場所及時期ニ依リテ異ナルモ、地災發生後加速度的ニ增大シ、二月中旬ニ於テハ其最大ニ達シ一晝夜ニ十四糎乃至四十二糎トナリ、其後漸次

第一圖　水平移動速度

Fig. 1. Velocity of horizontal displacement.



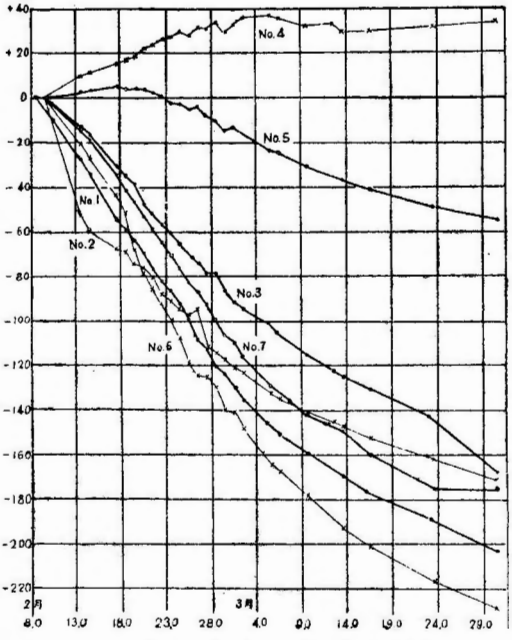
減退スル傾向ヲ示セリ　京都帝國大學理學部教授松山基範氏ハ變災地ニ松(1)—(7)ノ七點ヲ測点トシテ撰ヒ是等ノ移動ヲ變災地外ノ不動點ABCノ三點(附圖參照)ヨリ「うるど」萬能經緯儀ヲ以テ觀測シ、左ノ毎日水平移動速度(量)圖譜ヲ作製セラレタリ

右觀測ノ結果ニ依レハ變災地內測點ノ移動方向ハ一二ノ場合ヲ除ク外、時日ノ推移ニ伴ヘル著シキ變化ナク、イツレモ略南五十度東ノ方向ヲ示セリ　時日ノ推移ニ伴ヘル測點ノ水平移動速度ノ增減モ亦比較的規則正シク、各點相伴ヒテ增減セリ　最大移動速度ヲ示シタル二月九日ヨリ同月二

十七日ニ至ル間ノ各測點ノ一晝夜ニ於ケル水平移動速度ハ測點松(3)、(4)、ニ於テハ十糎乃至十八糎內外ニシテ常ニ比較的小、松(7)、(2)、(1)ニ於テハ二十六糎乃至四十二糎ニシテ常ニ比較的大ナリ　換言スレハ變災地內ノ水平移動速度ハ變災地ノ西半ニ於テ大、東半ニ於テ小ニシテ且西半部ノ中其北西部ハ其南東部ニ比シテ更ニ大ナリ　降雨、降雪ト水平移動速度トノ關係ハ、直接之ヲ批判スル資料ニ乏シキモ、二月十四日ノ降雨後ニハ各點ノ水平移動速度ハ一齊ニ增大セルヲ見ル　附圖上各測點ニ附セル矢印ハ二月十七日ヨリ二十一日ニ至ル五日間ノ水平移動方向ヲ示シ其大小ハ平均速度ノ大小ヲ比例的ニ示セルモノナリ

第二圖　垂直移動速度

Fig. 2. Velocity of vertical displacement.



（松山教授ニ依ル）　After Prof. Matsuyama.

垂直移動量ノ集積總量ハ測點松(4)ヲ除ク外ハ低下ヲ示セ

リ　而シテ最大低下量ヲ示セル松(6)ノ二月八日ヨリ三月二十九日ニ至ル四十九日間ノ平均一日ノ低下量ハ四糎七内外ナリ　變災地ノ北及北西部外廓ヲ成セル龜裂ニ伴フ垂直移動量ハ調査當時ニ於テハ一米五乃至一米六内外ニ達セリ

以上松山教授觀測ノ結果ニ依レハ、地辷運動ハ「ごくわん」段、南平ヲ包括スル西部及市ヶ平、長尾、及稻葉ノ地域ヲ含メル東部ノ二地塊ニ分レテ進行シタルモノヽ如ク、其移動方向ハ略同一ナルモ水平移動速度ハ之ヲ異ニセリ　又之ヲ龜裂發生ノ順序ニ就テ見ルモ、龜裂ハ先ツ西部地塊ニ始マリテ後東部地塊ニ及ヘルヲ以テ見レハ、本變災地ノ地辷運動ハ西部地塊ノ運動カ東部地塊ノ運動ヲ誘發シタルモノナルカ如シ

隆起量　峠斜面ニ起リタル地辷運動ハ其移動方向ノ末端部ニ隆起帶ヲ生セシメタル事ハ前述ノ如シ　以上ノ隆起帶中ノ隆起現象ノ最モ著シキハ大和川南岸ニ沿ヘル奈良、大阪線縣道面ニ起リタルモノニシテ其隆起量ハ奈良縣土木課ニ依リテ一月二十一日以來觀測ヲ續行セラレタリ　其結果次表ノ如シ

測點番號	觀測月日	觀測日數	累計隆起量(米)	平均一日隆起量(米)
奈(一)	自一月二十一日 至四月十四日	七六	—	—

〃	〃	〃	〃	〃	〃	〃	〃	〃
(二)	(三)	(四)	(五)	(六)	(七)	(八)	(九)	
〃	〃	〃	〃	〃	自一月卅一日至四月十四日	自二月十四日至四月十四日	〃	
〃	〃	〃	〃	〃	七一	六五	〃	
—	八・八〇八	七・九五五	八・三〇六	六・七九七	五・六一二	三・一二五	〇・三二一	
—	〇・一一六	〇・一〇五	〇・一〇九	〇・〇八九	〇・〇七八	〇・〇四三	〇・〇〇四	

觀測結果ヲ集積曲線ヲ以テ示セハ第三圖ノ如シ

龜ノ瀨隧道東口ノ東方百米ノ地點ヲ南北ニ通過スル龜裂ノ西部ハ著シク隆起シ、調査當時(二月二十六日)ニ於ケル舊鐵道線路面ノ垂直移動量ハ二米二六ニ達セリ (寫眞第四版第二、三圖參照)

三、變災地附近ノ地質

變災地附近ノ地質ハ左ノ如ク分類スル事ヲ得

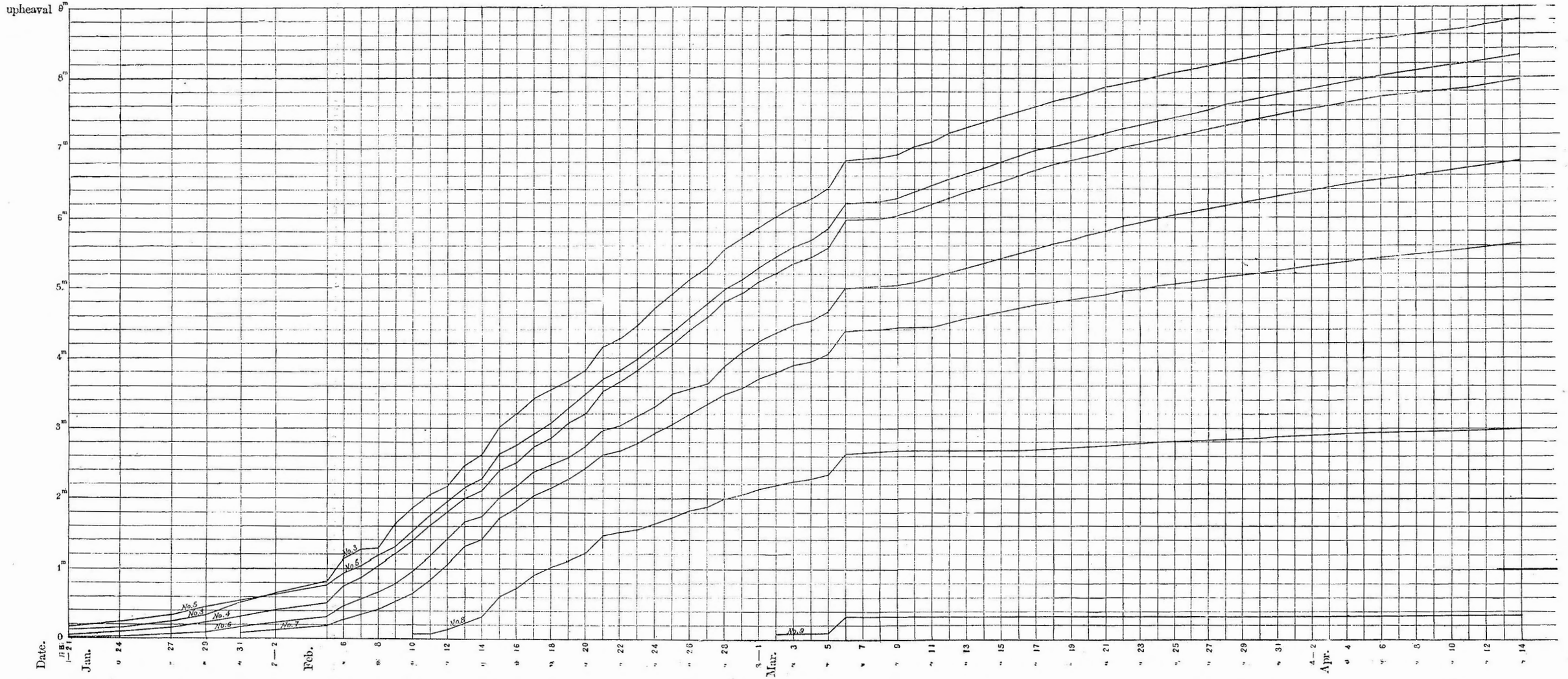
(甲)片麻岩質花崗岩
(乙)明神山熔岩
(丙)峠熔岩
　(一)古期熔岩
　(二)凝灰質角礫岩
　(三)新期熔岩
(丁)砂礫層
(戊)現世層
　(一)舊期沈積層
　(二)新期沈積層

(甲)片麻岩質花崗岩　本岩ハ本地方ノ基盤ヲ成セル岩石ニシテ明神山ノ中腹、王寺町藤井部落ノ西方ノ小區域、雁多尾畑、「とめしよ」間ノ鞍部ヨリ南方佛生堂直西ノ谷ニ沿ヒテ大和川ニ至ル線ノ西方ノ區域及長尾ノ東ノ谷ノ小區域ニ露出ス　本岩ハ黑雲母ヨリ成レル黑色部ト石

第三圖　大和川南岸奈良大阪縣道面隆起測定圖表

奈良縣土木課測定

Fig. 3. Cumulative curve showing the amount of the upheaval of land surface measured along the road of the southern bank of the Yamato-gawa.



(After the survey of Nara Prefectural Office)

英及長石ヨリ成レル白色部トカ交互シテ縞狀ヲ呈ス　黑雲母ハ六粍內外、長石及石英ハ三粍內外ノ大サノモノヲ普通トスルモ後者ハ八粍內外ニ達セルモノ少カラス　長石及石英ハ壓碎セラレテ粒狀ヲ呈シ、片麻岩質壓碎花崗岩ト稱スヘキモノナリ

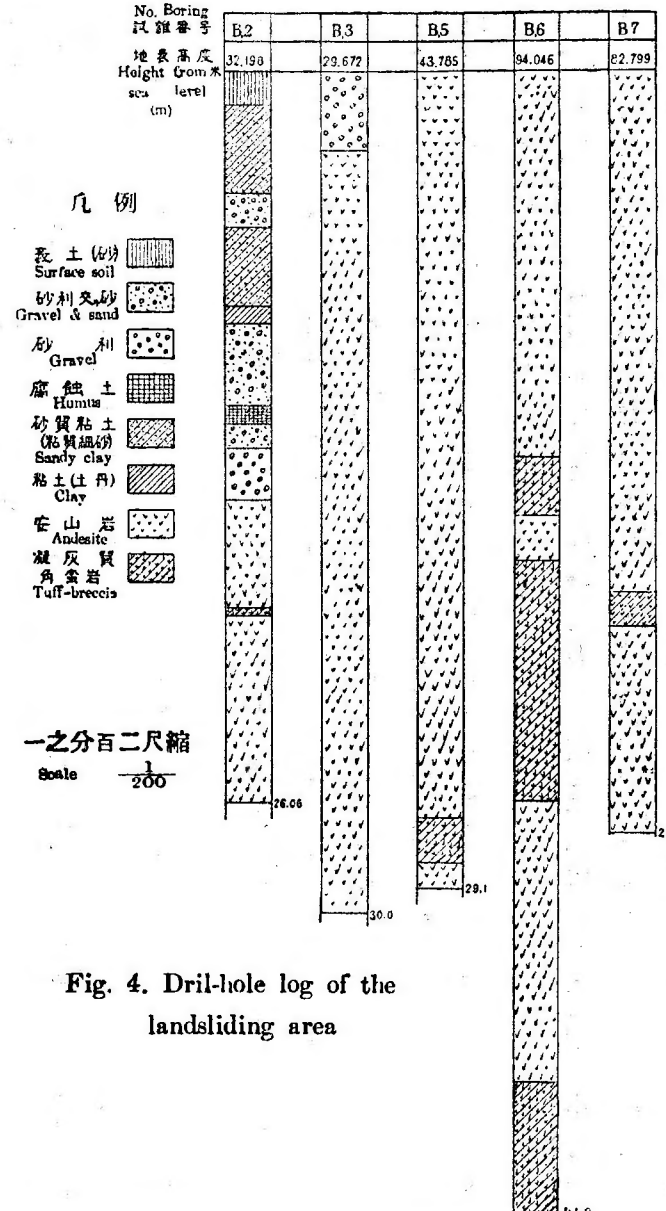
(乙)明神山熔岩　本岩ハ大和川ノ南岸ニ聳立スル明神山ヲ構成セル熔岩ニシテ、龜瀨隧道西口附近ニ於テ僅カニ大和川ヲ越エテ北岸ニ露出スルノ外ハ、大和川以南ノ地域ニ限ラレテ布在ス、本岩ハ極メテ緻密質ニシテ流理ヲ呈シ、斑晶ヲ有セサルヲ普通トス　新鮮ナルモノハ暗黑色ヲ呈セルモ、風化分解ノ程度ニ依リテ著シク其色澤ヲ異ニシ、全ク異種ノ岩石ノ如キ外觀ヲ呈セルモノアリ　稍風化分解シタルモノハ淡紫灰色ヲ呈シ多少脂肪光澤ヲ有シ、更ニ風化分解ノ進ミタルモノニ於テハ帶紫紅色ヨリ淡灰色トナリ、終ニ灰白色又ハ白色粘土質物質ニ化セリ　本岩ノ新鮮ナルモノハ極メテ緻密質ニシテ、顯微鏡下ニテモ個々ノ形態ヲ判別シ得サル微小長石及玻璃ヨリ成レル石基中ニ稀ニ大サ〇·三乃至〇·一粍ノ斜長石及黑雲母片ヲ有ス　隧道西口ノ南西對岸ニ露出セルモノハ黑色緻密質ニシテ長石及黑雲母ノ微晶ヲ含ミ流狀構造ヲ示セル石基中ニ極メテ少量ナルモ稍大形ノ斜方輝石及斜長石ノ斑晶ヲ有ス　斜方輝石ハ長柱狀ヲ呈シ、其大サ〇·一粍內外ニ達セルモノ少カラス　斜長石ハ大サ〇·五乃至〇·二粍內外ニシテ、中性乃至曹灰長石級ニ屬ス　即明神山熔岩ハ含黑雲母安山岩ト稱スヘキモノ

ナリ

(丙)峠熔岩　本岩ハ大和川以北ノ地域ニ露出シ、古期熔岩之ヲ被覆スル新期熔岩及新期熔岩ノ下部ニ挟有セラルヽ凝灰質角礫岩ニ區別スル事ヲ得

(一)古期熔岩　本岩ハ「とめしよ」高地ヲ中心トシテ略、求心狀ニ其南、東、北ニ分布セラレ、暗灰色緻密質ニシテ、長石ノ風化分解ニ依リテ生シタル一糎内外ノ黃灰色粘土質斑點ヲ含有シ板狀節理ニ富ムモ新期熔岩ニ比シテ著シカラス　其風化面ハ玉葱狀ニ剝離シ、且著シキ赤紫色又ハ黃灰色ノ風化分解色ヲ呈セルモノ多ク、又往々本地方ノ基盤ヲ成セル片麻岩質花崗岩ノ小破片ヲ捕獲セル事アリ　新鮮ナルモノヲ顯微鏡下ニ檢スルニ、淡キ多色性ヲ有スル斜方輝石最モ多ク、斜長石之ニ次キ、單斜輝石ハ極メテ少シ　斑晶ノ大サハ〇·三乃至一·五粍ニシテ一粍以下ナルヲ普通トシ、石基ハ斑晶ヲ成ス鑛物ノ微晶、玻璃及ヒ極メテ少量ノ黑雲母ヨリ成リ斜長石最モ多シ　本岩ハ含黑雲母兩輝石安山岩ト稱スヘキモノナリ　本岩中ニハ往々各組成鑛物間ノ間隙ヲ充シテ少量ノ石英存在セリ　恐ラクハ本岩ノ捕獲シタル片麻岩質花崗岩中ヨリ融蝕獲得シタルモノナルヘシ

(二)凝灰質角礫岩　本岩ハ「とめしよ」ノ南斜面カ急ニ斜面角ヲ變シテ峠緩斜臺地ニ移レル地域即、佛生堂「ごかん」段及市ヶ平北部ニ露出セル外、試錐ノ結果ニ依レハ試錐地質柱狀斷面圖ニ示



第四圖　變災地內試錐地質柱狀斷面圖

Fig. 4. Dril-hole log of the landsliding area

スカ如ク、新期熔岩中ニ一米乃至八米ノ厚ヲ以テ挟有セラル

本岩ハ著シク風化分解シ、新鮮ナル部分ヲ示サヽル爲メ、其原色、原質ヲ知ル事困難ナリ　露頭部ニ於ケル本岩ハ淡紅紫色ヲ呈シ、新期熔岩中ニ介在セルモノハ(試錐試料)第六號試錐ニ於ケル地表下三十六米ヨリ四十一米間ニ存在スルモノヽ紅紫色ヲ呈スルヲ除キテハ淡黄灰色ヲ呈セリ　本岩ハ風化分解シテ全ク粘土化セル凝灰質膠結物中ニ大サ小豆大乃至扁桃大ノ安山岩ノ角礫及圓礫ヲ多量ニ含有シ、露頭部ニ於ケル安山岩礫ノ風化分解ノ狀態ハ極メテ良ク古期熔岩ニ類似シテ紅紫色ヲ呈スルモ、新期熔岩中ニ介在セル本岩(試錐試料)中ノ安山岩礫ハ表面灰白色粘土ニ分解シ内部暗黒色ヲ呈スル新期熔岩礫ノミヲ含有セリ

峠部落西方大龜裂ノ下底、龜ノ瀬隧道西口ヨリ百米内外ノ隧道内及大和川「おわんがけ」ニ於テ地辷ノ爲メニ壓出セラレタル本岩中ニハ片麻岩質花崗岩礫ヲ混有シ、特ニ隧道ノ崩壊シタル際ニ壓出セラレタル本岩中ニハ其量特ニ著シカリシト云フ

(三)新期熔岩　本岩ハ兩輝石安山岩ニ屬シ、「とめしよ」附近、峠部落、南平、稻葉並ニ南平南方ノ對岸ノ小區域ニ露出シ、暗灰色緻密質ニシテ斑晶ヲ欠キ、板狀節理著シク發達セル爲メ厚サ五糎内外ノ板ヲ重疊シタルカ如キ外觀ヲ呈ス　組成鑛物ハ全ク古期熔岩ト同一ニシテ隨テ兩者ヲ造岩鑛物ニ依リテ區別スル事困難ナルモ、本岩カ古期熔岩ニ比シテ板狀節理著シキ事、風化

分解色ノ灰白ナル事、片麻岩質花崗岩片ヲ捕獲セルモノヲ見サル事等ニ依ツテ僅カニ區別スルヲ得

本岩ハ極メテ容易ニ風化分解シテ灰白色粘土ニ化ス　風化分解作用ハ先ツ岩石ノ表面及ヒ板狀節理ニ沿ヒテ進行シ、漸次其内部ニ及ヒ、終ニ岩石全部カ灰白色粘土化スルニ至ル　隨テ本岩ノ稍風化シ既ニ板狀節理面カ粘土化セルモノハ之ヲ鐵槌ニテ打ツ時ハ、破碎スル前ニ板狀節理ニ沿ヒテ容易ニ之ヲ二乃至三糎内外ノ板石ニ剝離スル事ヲ得　板狀節理ノ方向ハ峠部落、市ヶ平、稻葉及南平附近ニ於テハ走向南北ニ近ク、西方四十度乃至六十度ニ傾斜セルモノ多シ　峠部落直東ノ谷ニ露出セル本岩ハ其板狀節理カ成層岩ノ成層面ノ如ク良ク褶曲シ、或ハ岩屑ノ如ク破碎セラレ且節理ニ沿ヒテ粘土化セルヲ見ル　惟フニ本現象ハ其南部ニ於ケル稻葉丘ノ地形ト共ニ嘗テ今回ノ如キ地辷アリタル結果ナルヘシ

(丁)砂礫層　本層ハ長尾ノ東部並ニ其北東ノ地ニ廣ク賦存シ、又明神山頂上附近ニモ小區域ヲ成シテ露出セリ　本層ハ主トシテ良ク水洗セラレタル砂及礫ノ互層ヨリ成リ、下部ニ於テハ凝灰質ナリ

砂ハ黃灰又ハ灰色ヲ呈セル細粒花崗岩質砂ニシテ〇·五乃至一·五糎内外ノ扁平ナル礫ヲ混有ス

礫ハ直徑三糎內外ノ花崗岩及古生代硅岩、砂岩、粘板岩等ノ圓礫ヲ主トシ安山岩礫ヲ見ス
但東口假驛西方徒歩連絡道路側ニ露出セル砂礫層ハ峠新期熔岩中ニ見ルヲ得ヘキ粘土化セル安山岩塊ヲ混交ス

本層ハ更新期ニ屬スヘキモノト思考セラル

(戊)現世層　本層ハ大和川沿岸ノ平地ニ生シタル地層ニシテ大和川ノ氾濫ニ依リテ沈積シタル地層ナリ

舊期沈積層ハ舊大和川河床ニ於ケル沈積層ニシテ現在ノ河床ヨリ六米乃至十米ノ高所ニ成層ス　西口假驛對岸ニ於ケル本層ハ直徑一米以上ノ花崗岩漂礫ヲ多量ニ含メル砂礫層ニシテ「おわんがけ」對岸及藤井部落直西ノ川岸ニ於ケルモノハ細粒砂及青色粘土ヨリ成リ、嘗テ大和川ノ堰塞セラレテ淵ヲ生シタル際ノ沈積物ニシテ、這般河水堰塞ノ原因ハ或ハ今回ノ如キ地辷、地盤ノ隆起等カ嘗テ此地ニ起リタル爲メニアラサルカヲ想起セシム

新期沈積層ハ現時ノ河床ニ沈積セル砂、粘土、礫ヨリ成リ、稻葉ノ南西川岸ニ於テハ其厚サ十五米內外ナリトス

本變災地附近ニ露出セル片麻岩質花崗岩ハ生駒、葛城傾動地塊ヲ構成セル同岩ノ一部ニシ

テ本地方最古ノ岩石ナリ

明神山熔岩ハ二上火山ノ北端ヲ成セル明神山ヲ、峠熔岩ハ其北々西延長線上ニ位セル「とめしよ」及ヒ「どろころ」ノ小火山ト思惟セラルヽ圓頂丘ヲ夫々中心トシテ噴出シタルモノヽ如ク、更ニ同一方向ノ延長線上ニハ信貴山及生駒山ノ讃岐岩類小火山踞坐セリ　如斯小火山カ比較的規則正シク略一直線上ニ配列スルハ該方向ニ沿ヒテ火山岩ノ噴出シタル弱線ノ存在ヲ示スモノニアラサルカ

明神山熔岩ハ變災地附近ニ露出セル熔岩中最モ古ク噴出シタルモノニシテ峠古期熔岩之ニ次キ、續イテ降灰ト新期熔岩ノ噴出トカ交互ニ行ハレタル後、新期熔岩ノ大部分ノ流出アリタリ

砂礫層ハ明神山熔岩、峠古期熔岩ヲ被覆シ、峠新期熔岩ニ被覆セラル　亀瀬東口假驛ト隧道東口間ニ於ケル徒歩連絡道路ニ沿ヘル山麓ニ露出セル砂礫層ハ峠新期熔岩中ニ其板狀節理及流理ト並行的ニ挟有セラルヽ、事ヨリ見レハ峠新期熔岩ノ大部分ハ砂礫層沈積後ノ噴出ニ係ルモノナルモ其一部ハ少クモ同時代ノ噴出ニ係ルモノナリ

四、地災ノ原因

本地災ノ原因ニ關シテ江原博士ハ同氏ノ所謂槇尾斷層ノ滑動ニ因ルモノトシ、今村博士ハ同氏ノ假定セル名草斷層ニ沿ヘル地塊運動ニ歸セラルヽモノヽ如シ　上記兩氏假說ノ當否ハ今敢テ玆ニ論セサルモ、假ニ本變災地カ斯ル地質構造線上ニ在リテ、且ツ同線ニ沿ヒテ起リタル地動カ本地災ヲ誘導シタリトスルモ、今回ノ地辷運動ハ如斯長距離ニ亙レル地質構造線ニ沿ヒ、全汎的ニ起リタルモノニアラスシテ、特ニ本變災地ノミニ限ラレタルヲ思ヘハ、更ニ本地ノ地災ヲ惹起シタル直接ノ原因ナカラサルヘカラス　本報文ニ於テハ如斯意味ニ於ケル地災ノ直接原因ノミヲ考察セントス

本變災地ノ地質及ヒ地形ハ由來極メテ地辷ヲ誘發シ易キ素質ヲ有スルモノナルニ、更ニ人爲的施設ニ依リテ刺戟促進セラレタルモノナリ

前述ノ如ク、本變災地ヲ構成セル岩石ハ片麻岩質花崗岩ノ基盤上ニ噴出シタル熔岩類ニシテ、地災ノ起リタル大和川北岸ノ地ハ「とめしよ」或ハ「どろころ」小火山ヨリ噴出、大和川ニ向ヒテ流下セル峠熔岩ヨリ成レリ　峠熔岩ハ新舊兩熔岩ノ境界附近及新期熔岩ノ下部ニ凝灰質角礫岩ヲ挾ミ、該凝灰質角礫岩ハ露頭部ニ於テハ勿論、試錐ニ依ル地表下數十米ノ場所ニ於テモ腐朽分解シ、膠結物タル凝灰質物ハ勿論、甚シキ場合ニハ混有セラルヽ安山岩礫サヘモ全ク粘土化セリ　加之、峠新期熔岩自体モ亦極メテ容易ニ風化分解シテ粘土化スル性質ヲ有ス　峠

新期熔岩ニ極メテ良ク發達セル板狀節理ハ地表水ノ下降ヲ容易ナラシムル通路トナル爲メ、本岩ノ粘土化作用ハ板狀節理面ニ沿ウテ行ハレ且相當深處迄達セルモノヽ如シ　如斯粘土質物ヲ介有スル岩石ハ相當量ノ水ノ浸入ニ因リ粘土ノ可塑性著シク增大セラルヽ爲ニ、若シ粘土層ノ傾斜方向ト反對ナル上方ヨリ加壓セラルヽカ或ハ其下方ニ於ケル支持ヲ失フ場合ニハ、粘土層ヲ辷面トシテ夫ヨリ上部ノ岩石ハ傾斜ノ方向ニ滑落スルニ至ルヘシ　又逆ニ地災ノ結果ヨリ見ルモ凝灰質角礫岩カ地辷ニ極メテ密接ナル關係ヲ有スル事ハ次ノ事實ニ依リテ之ヲ察知スルヲ得ヘシ　即チ亀瀬隧道西口ヨリ八十乃至百米ヲ隔テタル隧道内ノ地點ニ於テ、地辷ノ爲メ崩壞シタル部分ハ明神山熔岩ト峠新期熔岩トノ間ニ介在セル凝灰質角礫岩ノ分解腐蝕シテ粘土化シタルモノヨリ成レリ　又大和川「おわんがけ」ニ於テ同樣ノ腐蝕粘土ハ隧道内ニ於ケルト同樣ニ明神山熔岩ト峠新期熔岩トノ境界附近ノ龜裂ニ沿ヒテ壓出セラレタリ　尙本地災カ夫婦塚附近即凝灰質角礫岩ノ露出セル區域ニ於テ先ツ發生シ、後他方ニ波及シタル事實モ凝灰角礫岩ト地辷トノ關係ノ密接ナルヲ語ルモノナリ

上述ノ如ク本變災地ハ極メテ地辷ヲ誘發シ易キ地質及地質構造ヨリ成ル外、更ニ其地形ハ一層之ヲ促進セシメタルモノヽ如シ　即チ本變災地ハ大和川ニ向ヘル臺地性緩斜地ニシテ、「とめしよ」小火山ノ南側斜面ハ畧ホ夫婦塚附近ニ於テ急ニ其斜度ヲ減シ、峠ノ臺地性緩斜地ニ

移レリ　緩斜地ハ急斜地ニ比シ地表水ヲ地下ニ滲透セシムルコト多ク又這般急斜地ト緩斜地トノ境界附近ハ高處ヨリ流下シ來レル地表水ノ一時滯溜スルニ適セリ　又峠部落民家ノ井戸カ新期峠熔岩ノ板狀節理ニ沿ヒテ循環スル地下水ヲ利用セルヲ見テモ明ナルカ如ク、峠新期熔岩ノ板狀節理ハ容易ニ地下水及地表水ヲ透過セシムルヲ以テ、本緩斜地ニ於ケル地表水ノ地下滲透量ハ地形ト相待ツテ普通ノ熔岩露出區域ニ於ケルヨリ遙カニ大ニシテ、新期熔岩下ニ潛在セル凝灰質角礫岩ノ粘土化及其可塑性ヲ增大セシムルニ十分ナリ　特ニ夫婦塚附近ニ於ケルカ如ク斜面角ノ變化スル箇所ニ凝灰質角礫岩露出セル場合ニハ、斜面角ノ變化ニ依リテ滯溜スル地表水ハ凝灰質角礫岩中ニ吸收セラルヽ機會多ク、爲メニ凝灰質角礫岩ノ粘土化及其可塑性ノ增大ハ一層促進セラルヘシ

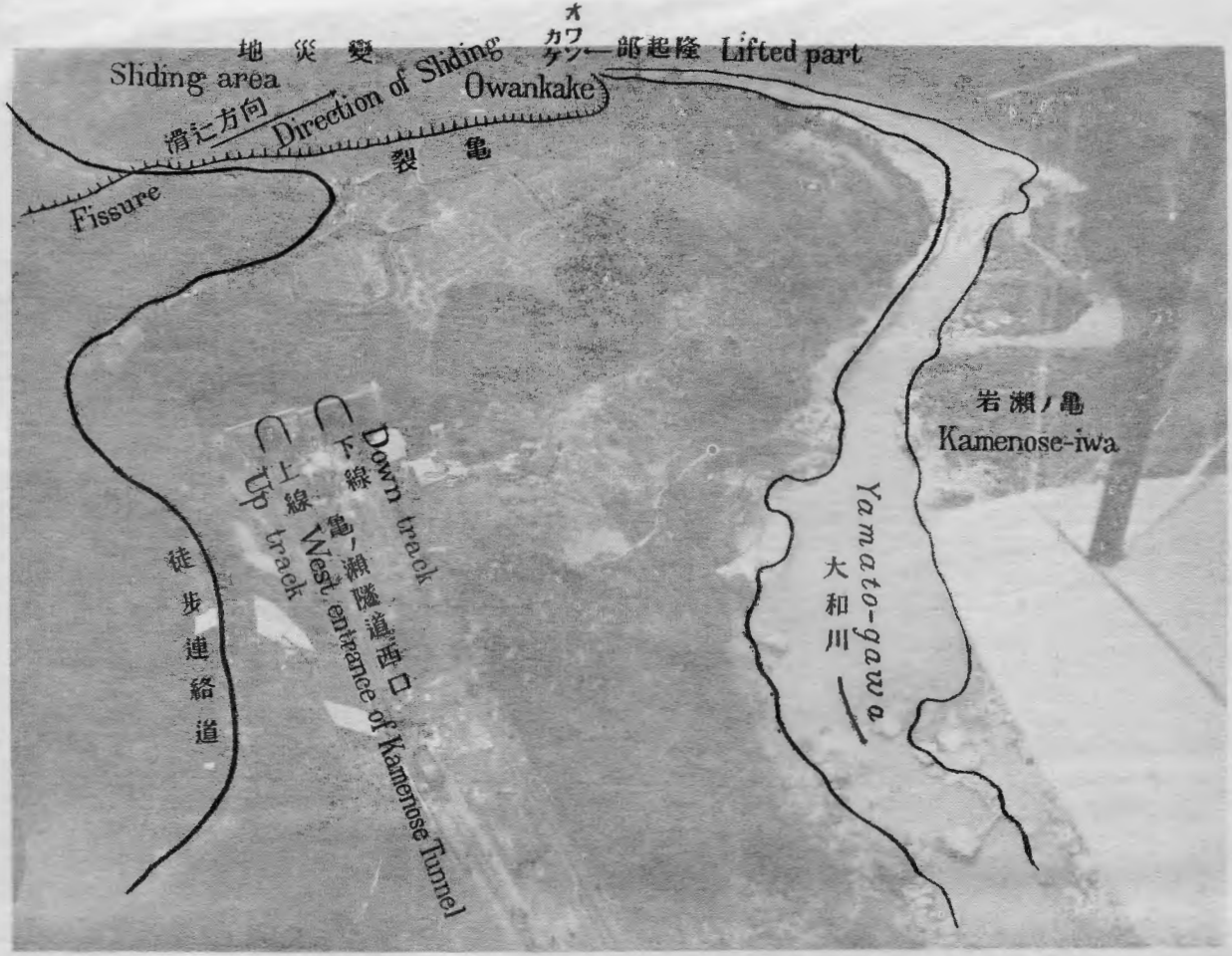
更ニ地形上本地ノ地辷ニ重大ナル關係ヲ有スルモノハ大和川峽谷ノ存在ナリトス　大和川ハ地質及地形上地盤ノ移動方向ニ直角ナル流路ヲ取リ、絕エス變災地ノ山脚ヲ洗ヘリ　若シ本變災地內ニ大和川峽谷カ存在セサレハ本變災地ハ直接明神山ニ倚肩シテ支持セラルヽヲ以テ、假令本變災地カ本質的ニ地災ヲ起シ易キ地質ナリトスルモ、今回ノ如キ地災ハ誘發セラルヽニ至ラサリシナラン

次ニ人爲的施設モ亦地災ノ時期ヲ早メタルモノヽ如シ　即チ近年峠臺地性緩斜地ノ森林

カ階段狀ニ開墾セラレテ果樹園及水田ニ變シタル事、水田灌漑用貯水池ヲ夫婦塚其他附近等高度ノ地域ニ多數設置シタル事等ハ地表水ノ地下ヘノ滲透ヲ增大シ、延イテハ凝灰質角礫岩及峠新期熔岩ノ分解腐朽ヲ助ケタリ　特ニ夫婦塚附近カ地災ノ始發地ナルコト、及ヒ凝灰質角礫岩露出區域ナルコトヲ併セ考フル時ハ、一層其感ヲ深フスヘシ

五、結　論

本地ノ地災ハ其地質及地形カ本質的ニ地災ヲ誘發シ易キモノナルト、人爲的施設カ一層之ヲ助長シルタニ依リテ惹起セラレタルモノニシテ、就中最モ重要且直接ノ原因ト思惟セラルルモノハ腐朽粘土化シタル凝灰質角礫岩カ峠新期熔岩ノ下ニ布在セル事ナリトス　隨テ本地ノ地災ハ此際一時終熄スルコトアリトスルモ、今後降雨、積雪ノ爲多量ノ地表水地下ニ滲透シ、凝灰質角礫岩ノ腐朽ニ因ル粘土ニ達スル事アル場合ニハ再ヒ惹起セラルヽ處アルモノナリトス



第一版 龜ノ瀬隧道西口附近

（大阪毎日新聞社飛行機撮影。變災初期）

Pl. I. *Kamenose-iwa* and the west entrance of the Kamenose tunnel.

第一版　龜ノ瀨隧道西口附近
（大阪毎日新聞社飛行機撮影。變災初期）

Pl. I.　*Kamenose-iwa* and the west entrance of the Kamenose tunnel.

第二版　龜ノ瀨岩及大和川河床ノ隆起

Pl. II. *Kamenose-iwa* and Lifted river bed of the Yamatogawa.

第一圖　龜ノ瀨岩附近（植村撮影）

Fig. 1. View of *Kamenose-iwa*.

v 龜ノ瀨岩 *Kamenose-iwa.*

vv 奈良・大阪線新縣道切取面
Excavation along the road in construction.

vvv 西口假驛
Temporary railway-station at the west entrance of the Kamenose tunnel.

第二圖

下流より大和川河床の隆起（二月初旬）を望む（大阪時事新報社撮影）

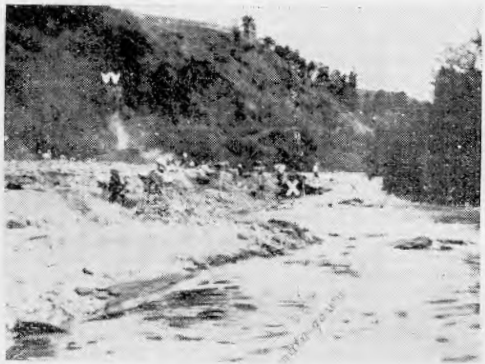


Fig. 2. Lifted river bed of the Yamatogawa seen from a spot downstream (Early in Feb.)

× 隆起部 Lifted portion.

vv 舊隧道口 Old tunnel.

第三圖

上流より大和川河床の隆起部（二月初旬）を望む（大阪時事新報社撮影）

Fig. 3. Lifted river bed seen from a spot upstream. (Early in Feb.)

v オワンカケ *Owankake.*

× 隆起部 Lifted river bed.

第三版 奈良・大阪線縣道面の隆起（二月二十七日 植村撮影）

Pl. III. Lifted part along the road in construction. (Feb. 27)

A 峠新期熔岩切取面 Excavated surface of the younger flow of Tōge lava.

B 舊期沈積層 Old Alluvium.

v 隆起せざる縣道面 Undisturbed road surface.

vv 隆起せる縣道面 Lifted road surface.

第一圖 下流より隆起部を見る

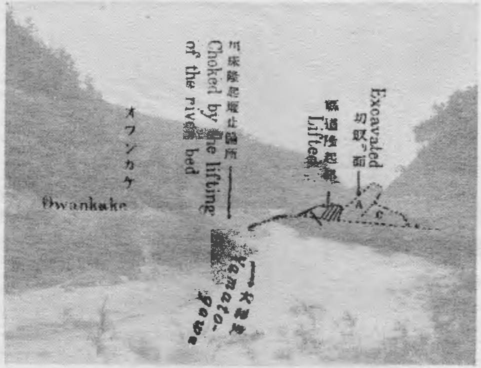


Fig. 1. Lifted part seen from a spot downstream.

第二圖 對岸（大阪府側）より縣道の隆起部を見る

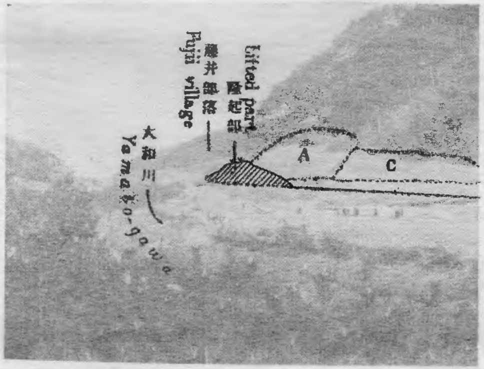


Fig. 2. Lifted part of the road seen from the opposite side of the river.

第三圖 隆起部近景

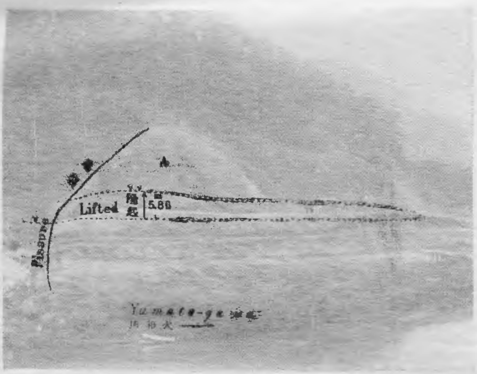


Fig. 3. Nearer view of the lifted part.

第四圖 隆起部近景

Fig. 4. Nearer view of the lifted part.

第三版　奈良・大阪線縣道面の隆起（二月二十七日　植村撮影）

Pl. Ⅲ.　Lifted part along the road in construction. (Feb. 27)

A　峠新期熔岩切取面　Excavated surface of the younger flow of Tōge lava.

B　舊期沈積層　Old Alluvium.

v　隆起せざる縣道面　Undisturbed road surface.

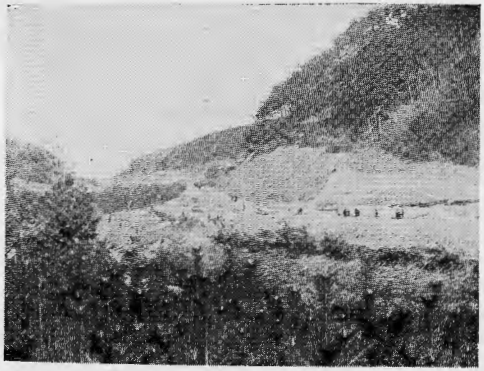
vv　隆起せる縣道面　Lifted road surface.

第一圖
下流より隆起部を見る

Fig. 1. Lifted part seen from a spot downstream.

第三圖
隆起部近景

Fig. 3. Nearer view of the lifted part.



第二圖
對岸（大阪府側）より縣道の隆起部を見る

Fig. 2. Lifted part of the road seen from the opposite side of the river.

第四圖
隆起部近景

Fig. 4. Nearer view of the lifted part.

第四版　龜ノ瀨隧道東口及其附近に於ける地變

Pl. IV.　The damages in the neighbourhood of the east entrance of the Kamenose tunnel.

第一圖　龜ノ瀨隧道東口全景（二月上旬・鐵道省撮影）

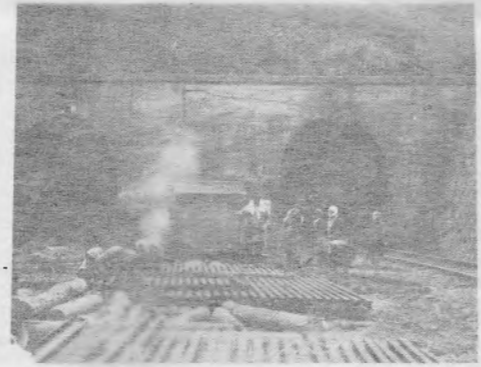


Fig. 1. The east entrance of the Kamenose tunnel. (Early in Feb.)

第二圖　龜ノ瀨隧道東口より百米東方に於ける軌條の彎曲（二月上旬・鐵道省撮影）

Fig. 2. The fissure limiting the eastern margin of the sliding area and the curved rails at the point 100 meters east of the east entrance of the Kamenose tunnel. (Early in Feb.)

第三圖　第二圖軌條の彎曲部以西の隆起（二月二十七日・植村撮影）

Fig. 3. Upheaval of the land to the west of the fissure shown in fig. 2, pl. IV. (Feb. 27)

第四版　龜ノ瀨隧道東口及其附近に於ける地變

Pl. IV.　The damages in the neighbourhood of the east entrance of the Kamenose tunnel.

第一圖　龜ノ瀨隧道東口全景（二月上旬・鐵道省撮影）

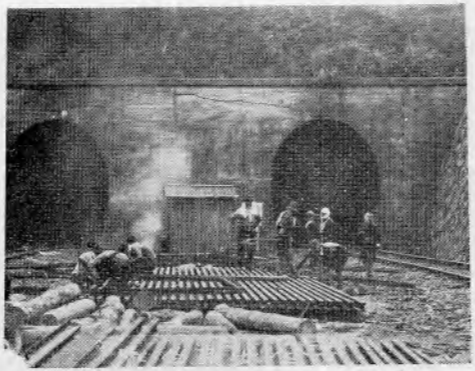


Fig. 1. The east entrance of the Kamenose tunnel. (Early in Feb.)

第二圖　龜ノ瀨隧道東口より百米東方に於ける軌條の彎曲（二月上旬・鐵道省撮影）

Fig. 2. The fissure limiting the eastern margin of the sliding area and the curved rails at the point 100 meters east of the east entrance of the Kamenose tunnel. (Early in Feb.)

第三圖　第二圖軌條の彎曲部以西の隆起（二月二十七日・植村撮影）

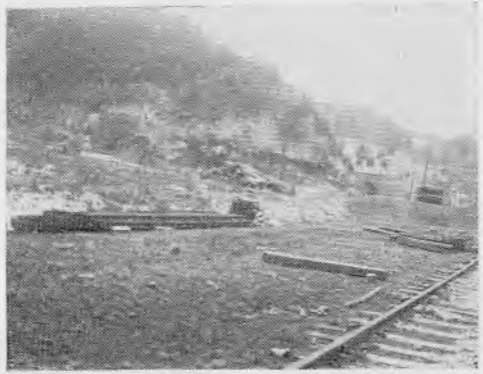
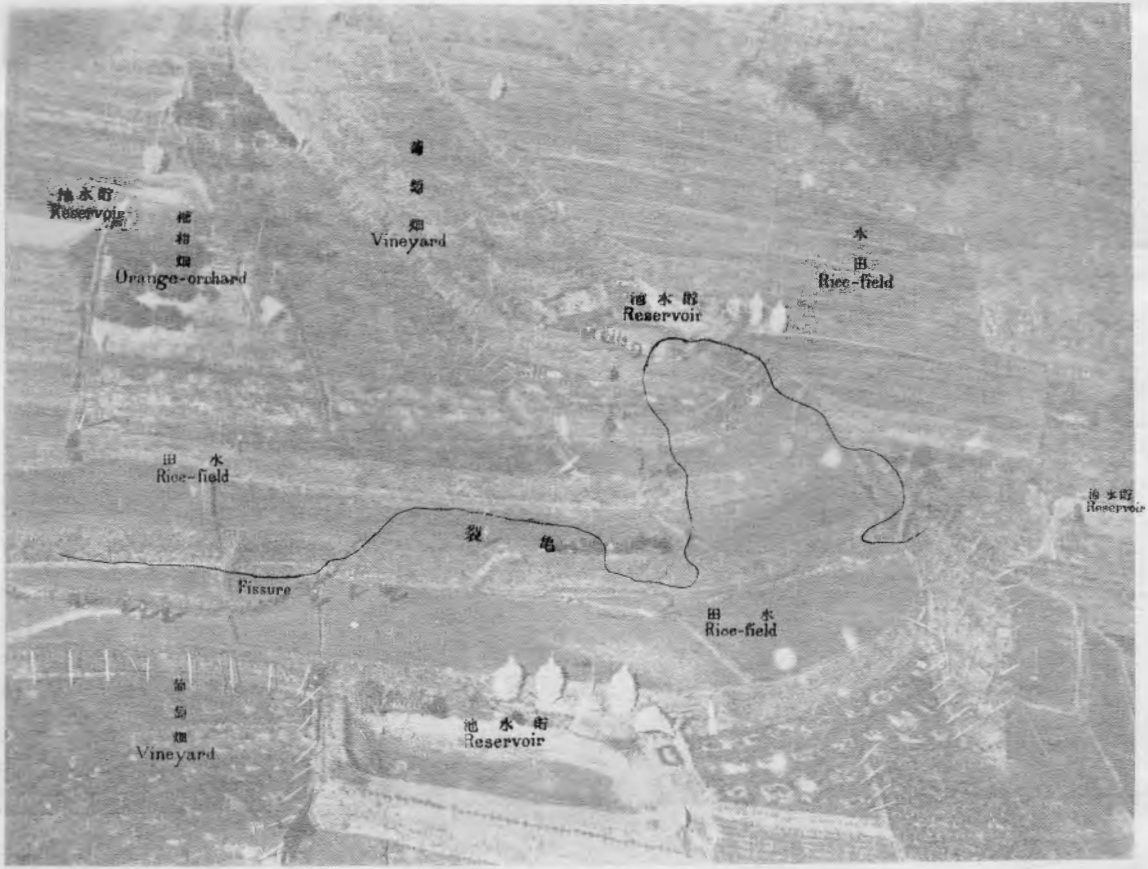
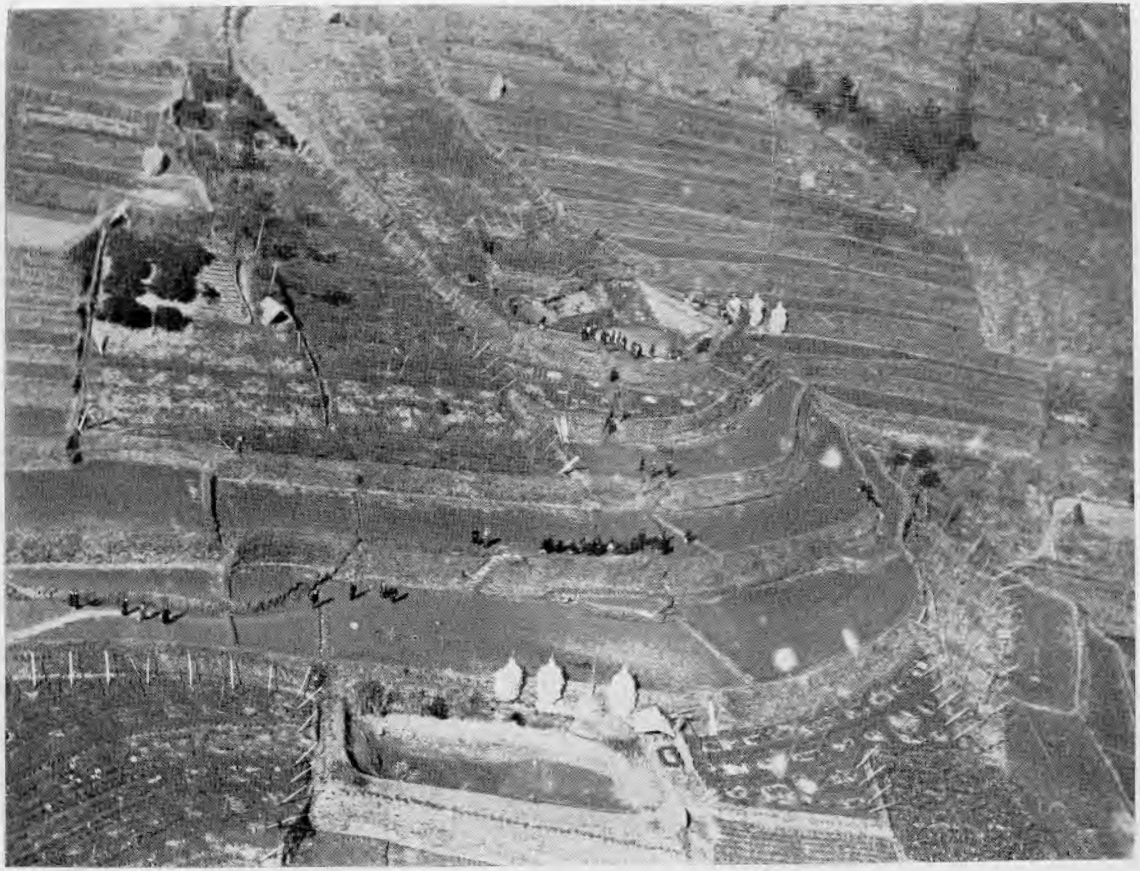


Fig. 3. Upheaval of the land to the west of the fissure shown in fig. 2, pl. IV. (Feb. 27)

地辷開始直後夫婦濵東部に發生せる龜裂と峠嶺地性緩斜地々形
（大阪毎日新聞社飛行機撮影）



Pl. V. Gently sloping topography of the landsliding area and fissures formed in the early stage of the landslide.



第五版

地辷開始直後夫婦塚東部に發生せる龜裂と峠嶺地性緩斜地々形

（大阪毎日新聞社飛行機撮影）

Pl. V. Gently sloping topography of the landsliding area and fissures formed in the early stage of the landslide.

第六版

夫婦塚附近の龜裂と、隧道直上に生じたる陷沒穿（二月下旬植村撮影）

Pl. VI. Fissures at Fūfuzuka and one of the depression holes appeared just above the tunnel. (Late in Feb.)

第一圖
夫婦塚直南に於ける龜裂

Fig. 1. Fissures on the south of Fūfuzuka.

第二圖
夫婦塚南方に於て東西に走る大龜裂を東方に向ひて望む

Fig. 2. Fissures on the south of seen from the west.

第三圖
第二圖と同じ、龜裂の內部

Fig. 3. The same as fig. 2. Internal view of the fissure.

第四圖
峠部落南方隧道直上に生じたる陷沒穿と板狀節理に富む峠新期熔岩

Fig. 4. Depression hole made on the south of Tōge village, just above the tunnel. The Tōge younger lava rich in platy joints.

第七版

峠部落に於ける被害と、峠新期熔岩（二月下旬植村撮影）

Pl. VII. The damages at the Tōge village and an exposure of the Tōge younger lava. (Late in Feb.)

第一圖

龜裂線上の家屋（屋根彎曲す）と石垣の胎み出し

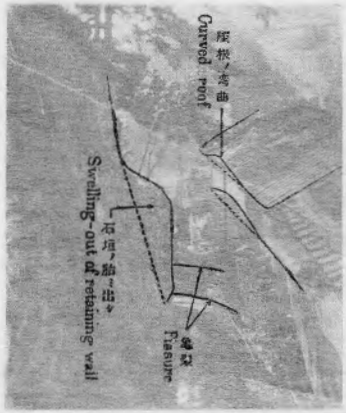


Fig. 1. Broken houses and swelled out retaining wall on the fissure line.

第二圖

龜裂線上家屋の傾斜

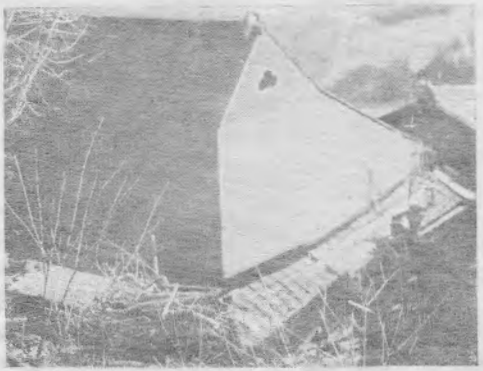


Fig. 2. Tilting of a house on the fissure line

第三圖

土地の傾動に依る葡萄畑杭基石の移動

Fig. 3. Sifting of the stake-stone of vineyard by the tilting of land.

第四圖

峠新期熔岩の板狀節理

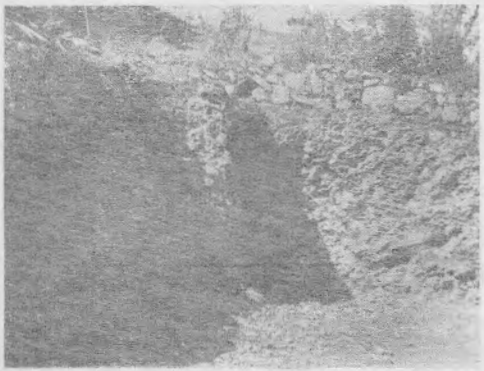
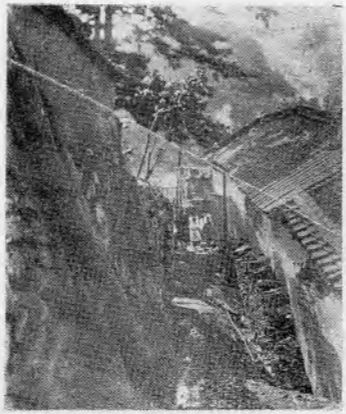


Fig. 4. Platy joints of the Tōge younger lava.

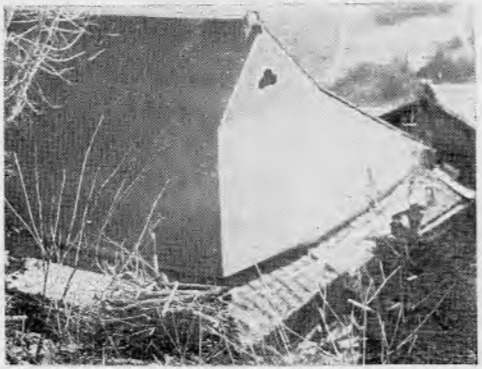
第七版

Pl. Ⅶ. 峠部落に於ける被害と、峠新期熔岩（二月下旬植村撮影）
The damages at the Tōge village and an exposure of the Tōge younger lava. (Late in Feb.)



第一圖
龜裂線上の家屋（屋根彎曲す）と石垣の跡み出し

Fig. 1. Broken houses and swelled out retaining wall on the fissure line.

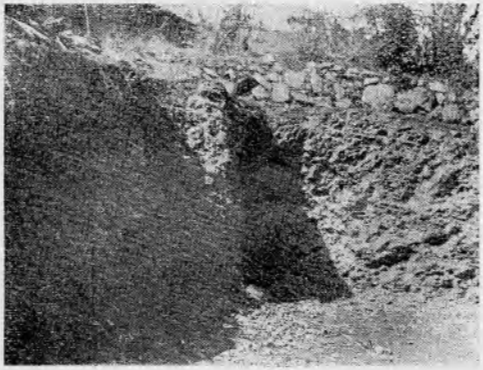


第二圖
龜裂線上家屋の傾斜

Fig. 2. Tilting of a house on the fissure line

第三圖
土地の傾動に依る葡萄畑杭基石の移動

Fig. 3.. Sifting of the stake-stone of vineyard by the tilting of land.



第四圖
峠新期熔岩の板狀節理

Fig. 4. Platy joints of the Tōge younger lava.

第八版

Pl. Ⅷ.

隧道の被害(鐵道省一月下旬撮影)

The Damages of the Kannose tunnel. (Late in Jan.)

第一圖　上り線「レール・センター」補强工事の歪曲

Fig. 1. Sifting and curving of the rail-center, up-track.

第二圖　同右

Fig. 2. The same as fig, 1.

Pl. Ⅸ. Cracks appeared in the lining wall of the Kamenose tunnel, up-track. (Late in Jan.)

第九版

上り線隧道内壁に生じたる龜裂

GEOLOGICAL MAP OF THE LANDSLIDING AREA AT TŌGE IN KATAKAMIMURA, NAKAKAWACHI-GUN IN THE PREFECTURE OF ŌSAKA

SURVEYED FEB. 23–28, 1932.

大阪府中河内郡堅上村
大字峠附近地震變災地地質圖

測量 自昭和七年二月二十三日 至同二十八日

一之分万二尺縮
Scale 1:20,000

比例尺四千分之一
Scale 1:4,000

高距海面上毎三米実
Contours 3 meters Vertical Interval

- 崖錐 Talus
- 新期沈積層 Younger Alluvium
- 舊期沈積層 Older Alluvium
  - 現世統 Recent
- 砂礫層 Sand and Gravel
  - 更新統 Pleistocene
- 新期 Younger Flow
- 凝灰質角礫岩 Tuff Breccia
- 古期 Older Flow
  - 峠熔岩 Tōge Lava
- 明神山熔岩 Myōjinyama Lava
- 片麻岩質花崗岩 Gneissic Granite
- 陥没穴 Depression Hole
- 龜裂 Fissure
- 隆起 Uplifted Land
- 松山氏標準點 / 同測點 Observation Station for Displacement by Prof. Matsuyama of Kyōto Imp. Univ.
- 奈良縣土木課測點 Observation Station for Displacement by Messrs. of Nara Prefectural Office
- 試錐位置 Boring
- 矢ノ方向ハ移動ノ方向ヲ示シ、長短ハ自二月十七日至同月廿一日ノ平均水平速度ノ大小ヲ比例的ニ示ス Arrow shows the Direction and Magnitude of Average Horizontal Displacement during Feb. 17—21, 1932.

昭和七年十二月二十日印刷
昭和七年十二月二十五日發行

定價金壹圓拾貳錢
郵稅金四錢

商工省

印刷者　橫濱市中區笹下町松本七三一番地　豊田作治郎

印刷所　橫濱市中區笹下町松本七三一番地　東京地學協會印刷部

發行所　東京市麹町區下二番町四十八番地　東京地學協會

IMPERIAL GEOLOGICAL SURVEY OF JAPAN

REPORT No. 114

The Landslide at Tōge in Katakami-mura, Nakakawachi-gun in the Prefecture of Ōsaka.

KIMIO UYEMURA.

(Abstract)

At the end of November of 1931, a small fissure in the ground was discovered on the north of the village of Tōge which is situated at about half way between Ōsaka and Nara, on the north bank of the Yamato-gawa (river). Subsequently, the fissurings and landslidings of this region were extended day by day, and inflicted awful damages on the houses and farms of the village of Tōge, destructing communication systems at the same time.

Among these damages, the most serious was the collapse of the Kamenose tunnel on the Kwansai main line of the Imperial Government Railway, which is one of the important tracks in Japan. The river bed of the Yamato-gawa was upheaved and the river water was choked up so as to throw the inhabitants of the upper course of the river into a fear of flooding. By these damages, it is reported that an expense of about two million yen would be necessary for the reconstruction of the railway and road-systems as well as the sifting and deepening of the Yamato-gawa course.

Physiography of the Sliding Area

The locality where this disaster occurred is just above the *Kamenose-iwa*

(a special name for a peculiar rock), famous in poetry since ancient times. The both sides of the Yamato-gawa in the neighbourhood of the landsliding area are quite dissimilar and make a conspicuous contrast in their topographical features. The north side of the river, that is the landsliding area, is a terrace-like gently sloping land, while the south side is formed of the steep slope of Myōjin-yama (mountain), 274.9 meters high above the sea level.

At the back of the disturbed area, there are two small volcanic cones called Tomeshc-yama (276.4 meters) and Dorokoro-yama (312.9 meters), sloping down toward the Yamato-gawa to south and southeast. The southern and southeastern slopes of these cones abruptly change the angle of inclination along the contour line of about one hundred fifty meters and pass into the terrace-like gently sloping land of Tōge, i. e., the landsliding area.

The area is well cultivated and occupied by vineyards, orange-groves and ricefields. Along with the development of ricefields, the water reservoirs for irrigation have been increased in their number since twenty years ago, being almost always located at the level of about one hundred thirty meters contour line.

Land Deformation

Area and Boundaries The landslide has been observed in an area of nearly thirty two hectares of roughly oval shape with a long axis, six hundred and fifty meters long, running from northeast to southwest and a short axis, five hundred and forty meters long, running from northwest to southeast.

This disturbed area is separated from the neighbouring undisturbed land by fissures or crevasses. The fissure lines which form the boundaries of the southwestern and eastern borders of the disturbed area are fairly simple or linear, but that of the northwestern boundary is a

combination of four horse-shoe shaped earth-cracks with openings toward south or southeast, arranged side by side in a direction running from southwest to northeast.

Progress of the Deformation The first fissure appeared in this region, though not conspicuous, was discovered on November 27, 1931 at Fūfuzuka, about two hundred meters northwest of the village of Tōge. This fissure, had been enlarged day after day, not only in width but also in extent, untill in early January the large fissures traversing the village of Tōge and those forming boundaries of the whole sliding area completely came in sight. So the main displacement seems to have been originated at the northwestern corner of the disturbed area, and the land-mass of the area appears to have gradually slipped down toward the Yamato-gawa.

In the middle of January, the upheavals of the land became observable along the eastern and southern margins of the sliding area. These upheavals are conspicuous especially at the southern margin of the area, i. e., along the road in construction on the south bank of the Yamato-gawa. The amount of the upheaval along the road was measured at 8.8 meters up to April 14, 1932. (c. f. fig. 3)

Direction and Amount of Displacement The direction of the displacement coincides with that of the slope of Tōge, being S. 50° E. in average. Though we could not directly measure the angle of inclination of the sliding plane in the field, we can conjecture it by the following observations. As already mentioned, the fissure line of the northwestern boundary of the sliding area is wavy, while the others are fairly simple or linear. Added to this, we know that the direction of sliding coincides with that of the slope. These data may suggest that the fissure line of the northwestern boundary of the sliding area should be the locus of intersection of the sliding plane with the surface of the slope in the same direction but with different angles. Estimating

the curvature of the wavy course of the fissure line on the topographic map, we can calculate that the angle of the inclination of the sliding plane should be less than fifteen degrees.

The amount of the horizontal displacement of the slide was various in different places and dates, but according to the observation of Professor Matsuyama of Kyoto University, it became greater and greater day after day, being increased almost regularly, and attained its maximum in the middle of February, fourteen to forty centimeters a day, then inclining to decrease afterwards. (c. f. fig. 1) The daily vertical displacement was −4.7 centimeters in average, during the period from February 8 to March 29, 1932. (c. f. fig. 2)

Geology

The rocks of the sliding area and its neighbourhood may be classified and arranged as follows from the older to the younger.

(A) Gneissic Granite
(B) Myōjin-yama Lava
(C) Tōge Lava
  (1) Older flow
  (2) Tuff Breccia
  (3) Younger flow
(D) Pleistocene ? Sand and Gravel
(E) Recent
  (1) Older Alluvium
  (2) Younger Alluvium
  (3) Talus

The oldest rock which constitutes the basement of this region is a coarse grained gneissic biotite-granite. On this basement the Myōjin-yama lava and the Tōge lava were spread and occupy nearly the whole sliding area. These two kinds of lavas seem to have three centers of

eruption: for the former, Myōjin-yama on the south bank of the Yamato-gawa; for the latter, Tomesho and Dorokoro-yama on the north bank. The Myōjin-yama lava is older than the Tōge lava and is found chiefly on the south side of the river, except a small area near the west entrance of the Kamenose tunnel. This lava is a biotite-bearing andesite of very compact texture with fluidal structure and is easily susceptible to decompose into clayey substances of white, purple, red or gray colour.

The Tōge lava is a two-pyroxene andesite of "Sanukite" type, intercalating a tuff breccia in the lower part of its younger flow (c. f. fig. 4), or between its older and younger flows. This lava is very compact and very rich in platy joints which are especially conspicuous in the younger flow (c. f. Pl. Vll. fig. 4), and is mostly decomposed into clayey substances along the exposed surface, platy joints or cracks. The tuff breccia crops out chiefly at Bushōdo and Gokuwandan where the southern slope of Tomesho-yama abruptly change its angle of inclination. From the results of the earth-borings tried in the disturbed area (c. f. fig. 4), the thickness of the tuff breccia intercalated in the younger flow is measured at one to eight meters. We could not examine any fresh unaltered tuff breccia, because this rock is completely decomposed even the hand specimens from the borehole of a depth of about forty meters. At the outcrop it is purple red or light yellowish gray in colour and consists of completely decomposed clayey substances, and small angular or rounded pieces of andesite of pea or peach size.

Sand and gravel formation borders on the east and northeast of the sliding area, and probably belongs to the Pleistocene epoch.

Alluvial sand, clay and gravel beds are developed along the course of the Yamato-gawa.

Cause of the Landslide

The cause of the landslide of this area may be ascribed to the combination of (1) the presence of the Tōge lava (2) the topography and (3) the action of the percolating water from water-reservoirs.

The disturbed area is wholly occupied by the Tōge lava intercalated with tuff breccia. This lava is considered to have been extruded from two centers, Tomesho-yama and Dorokoro-yama on the north of the village of Tōge, and flowed down toward the Yamato-gawa, forming the present topography of a terrace-like gently sloping land. The predominance of platy joints and cracks in the Tōge-lava makes surface water easy to circulate down to the interbedded tuff breccia which, retaining a large amount of the descending water, would be rendered loose so as to let the overburden to slip down. As mentioned before, there are numerous water reservoirs recently built along the contour line of about one hundred thirty meters, where comparatively steep slopes abruptly pass into the gently sloping land of Tōge and where the tuff breccia is exposed. Such relation between the water-reservoirs and the topography and geology of the district would suffice to let one consider the cause of the disaster as follows:

The bed of tuff-breccia, which lie underground with a gentle dip toward the Yamato-gawa (river), has been made loose by the percolating water leaking from the water-reservoirs recently built, and has caused the land-mass upon it to move down toward the river.

IMPERIAL

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OF

JAPAN

REPORT No. 114

TOKYO 1932