

Seismographs and Seismograms

Yoshio Okamoto

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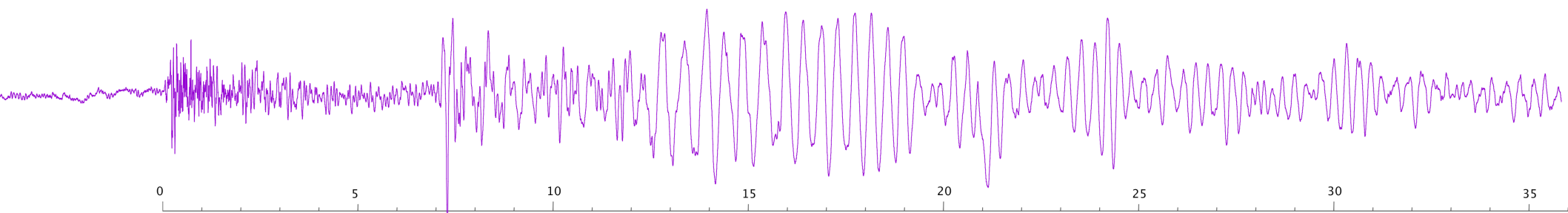
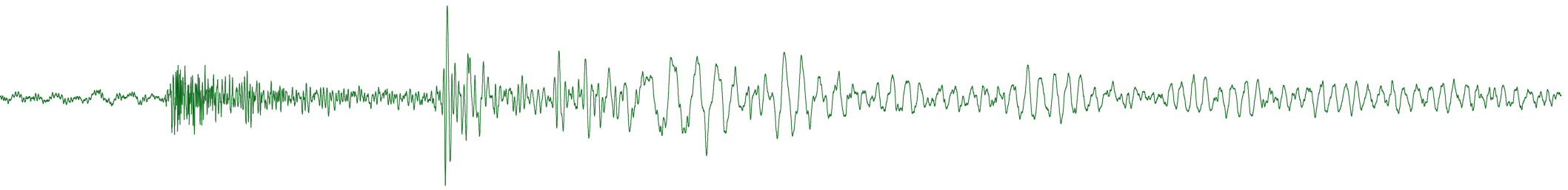
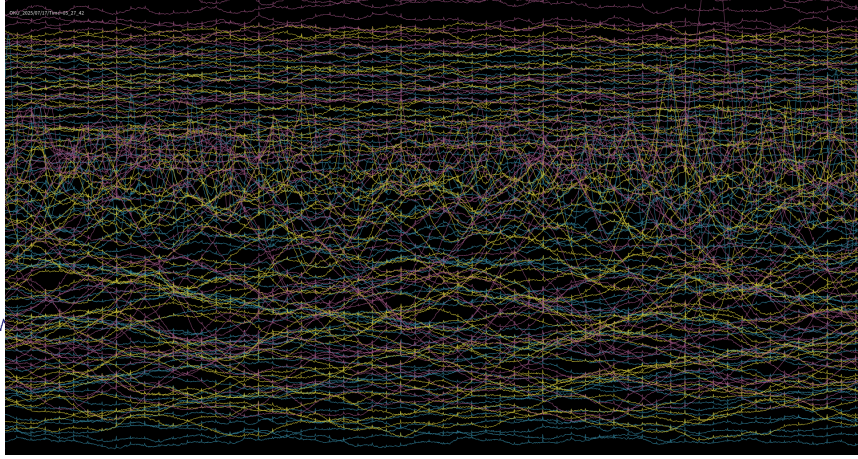
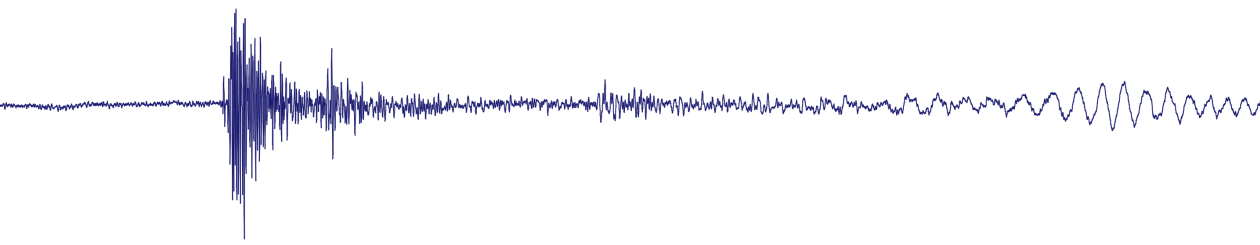
2025-07-25 at Hirakawa Labo.

Who am I ?

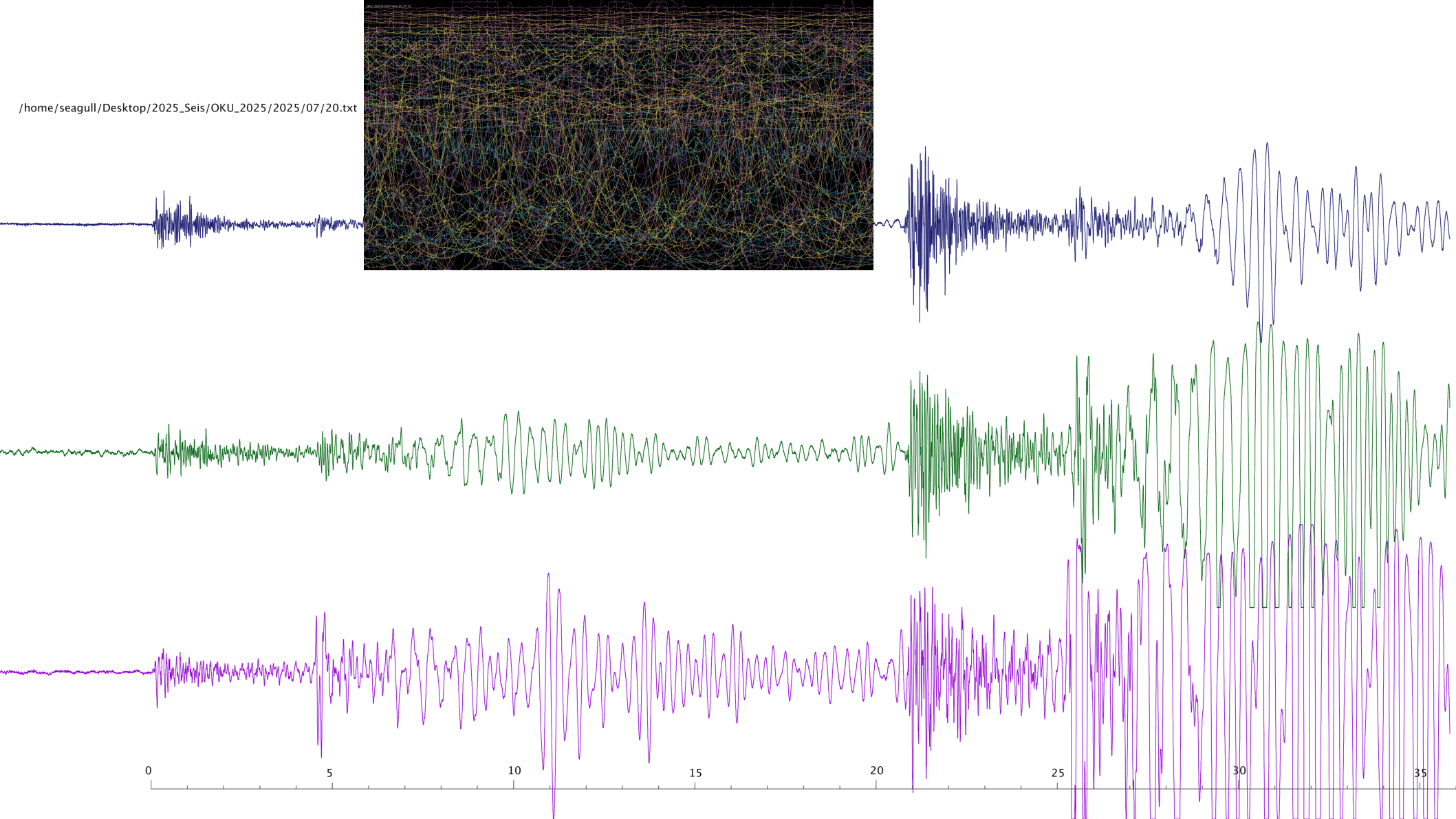


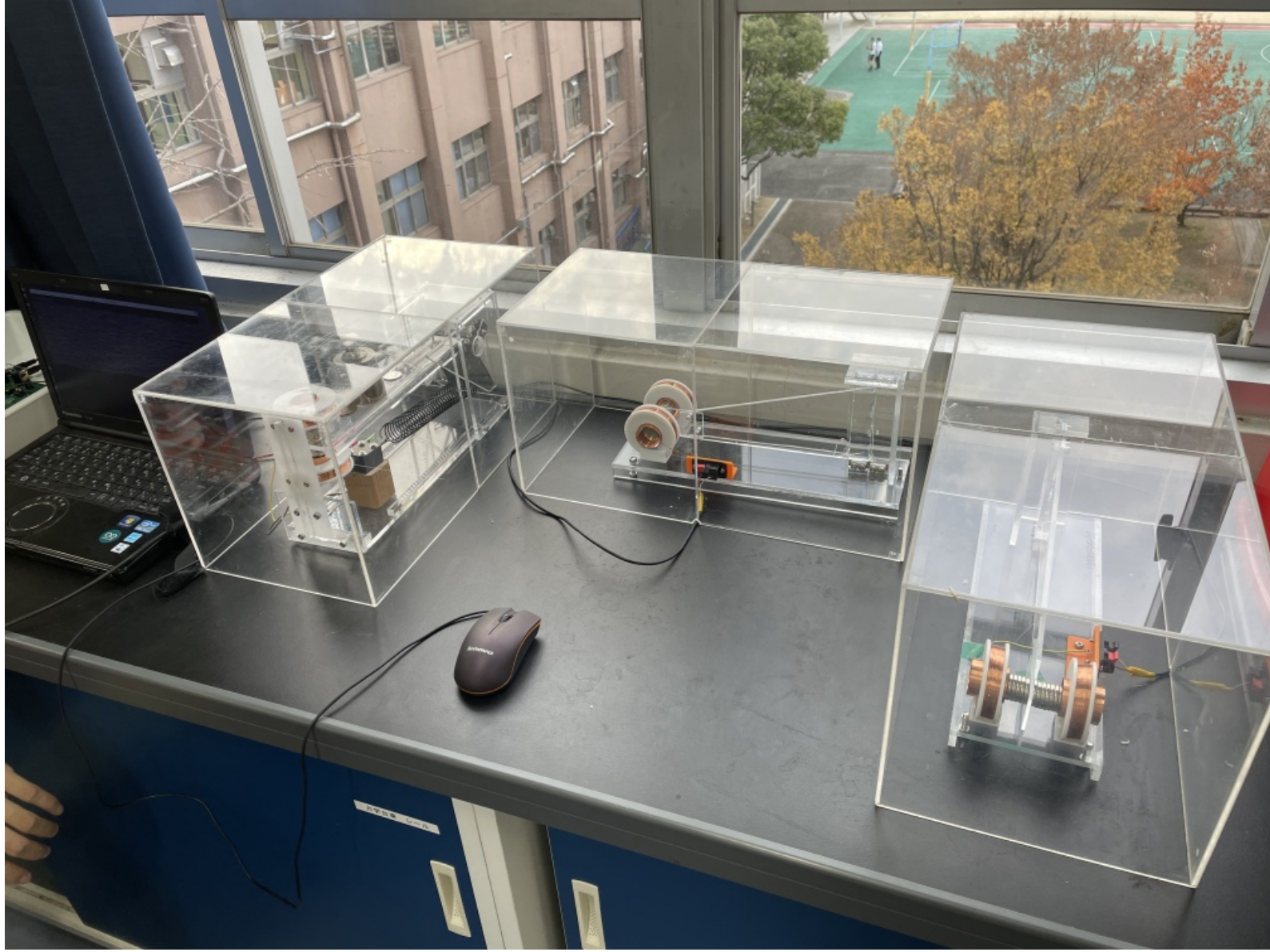
- 40年近くにわたり 高校で地学担当教員（今は退職）
- この間大阪府教育センター, 大学で研究も行う
- 地学教育とりわけ地震や海外の地質などに興味
- 日本と世界の地質サイトを行脚
- 地学教材を開発（地震計, 3D震源地図, 岩石薄片など）
- Linux上の**Programing**と**英語**を勧める
- 2012年より, 特任准教授および非常勤で本学で教養「地球と災害」, 専門「固体地球科学II」担当
- 2017年より, 夏～秋の2ヶ月間, タイのサイエンス高校 (KVIS) の高3生の地学を英語で担当（2019年より3年間COVID-19でタイの仕事はお休み）
- 2022年からあらたにタイのサイエンス高校 (PCSHS Mukdahan校, Loei校など) のvisiting teacher（不定期）で現在に至る.

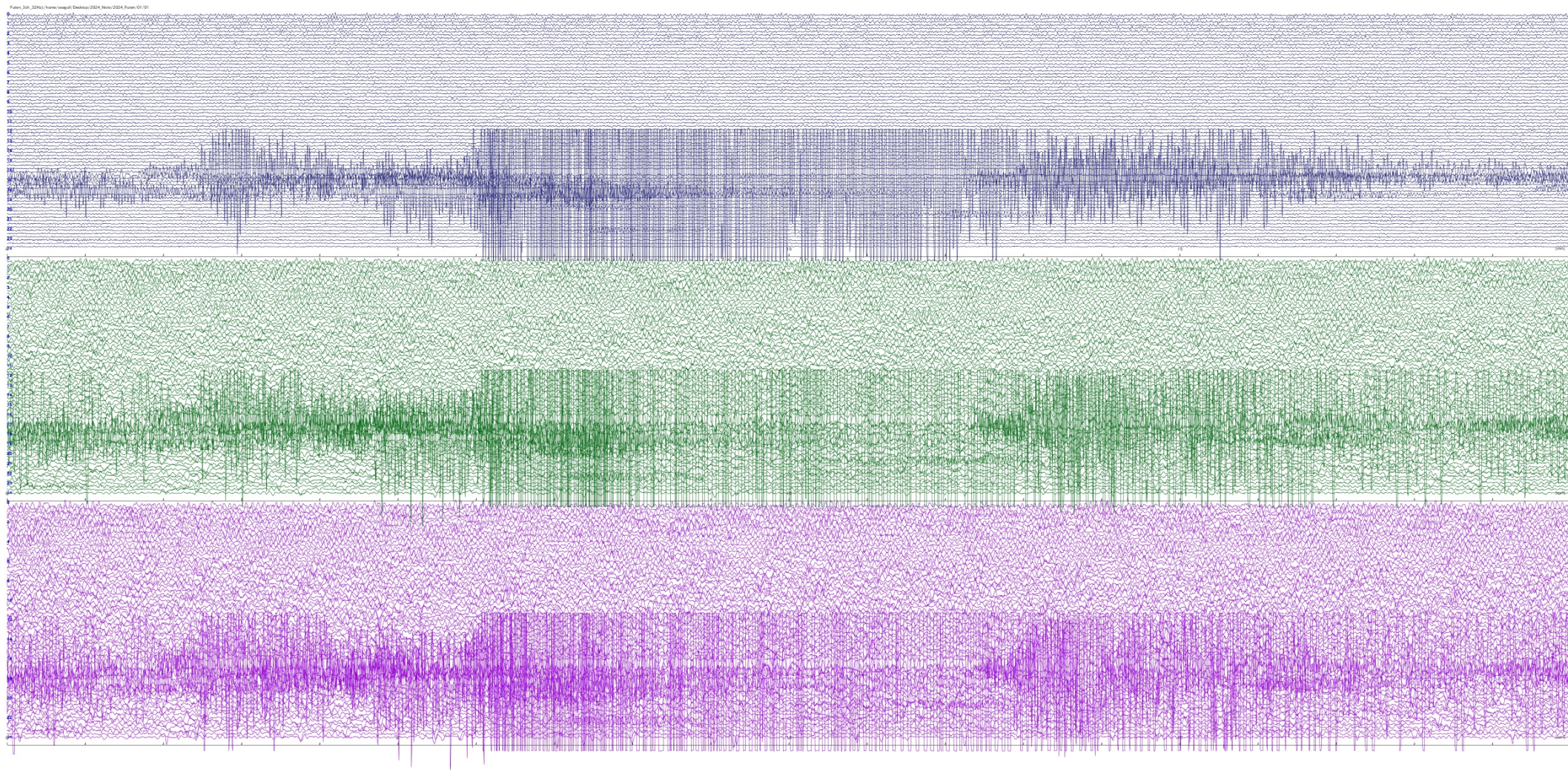
/home/seagull/Desktop/2025_Seis/OKU_2025/2025/07/17.txt M 7.3 h=20.1km 2025 Sand Point, Alaska Earthquake

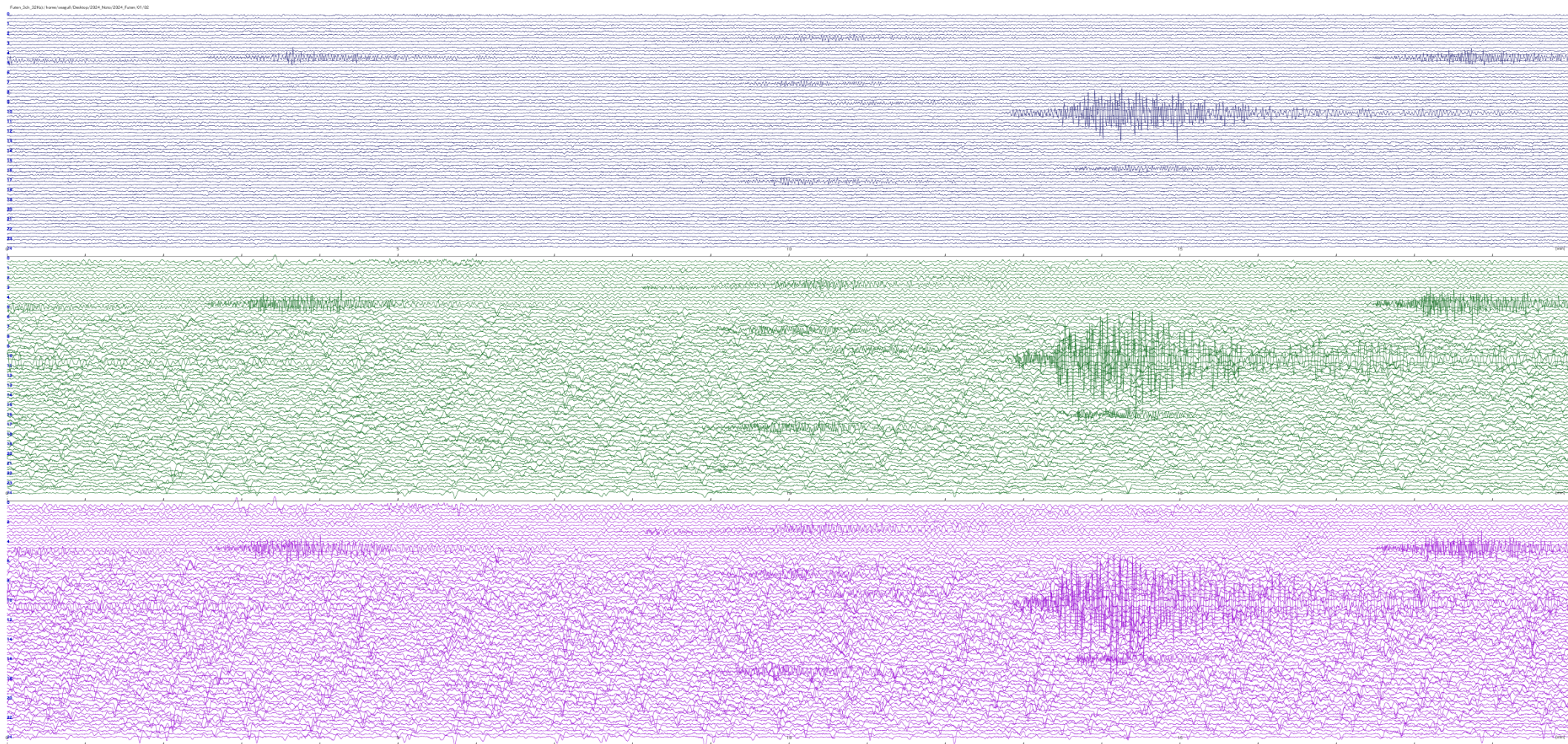


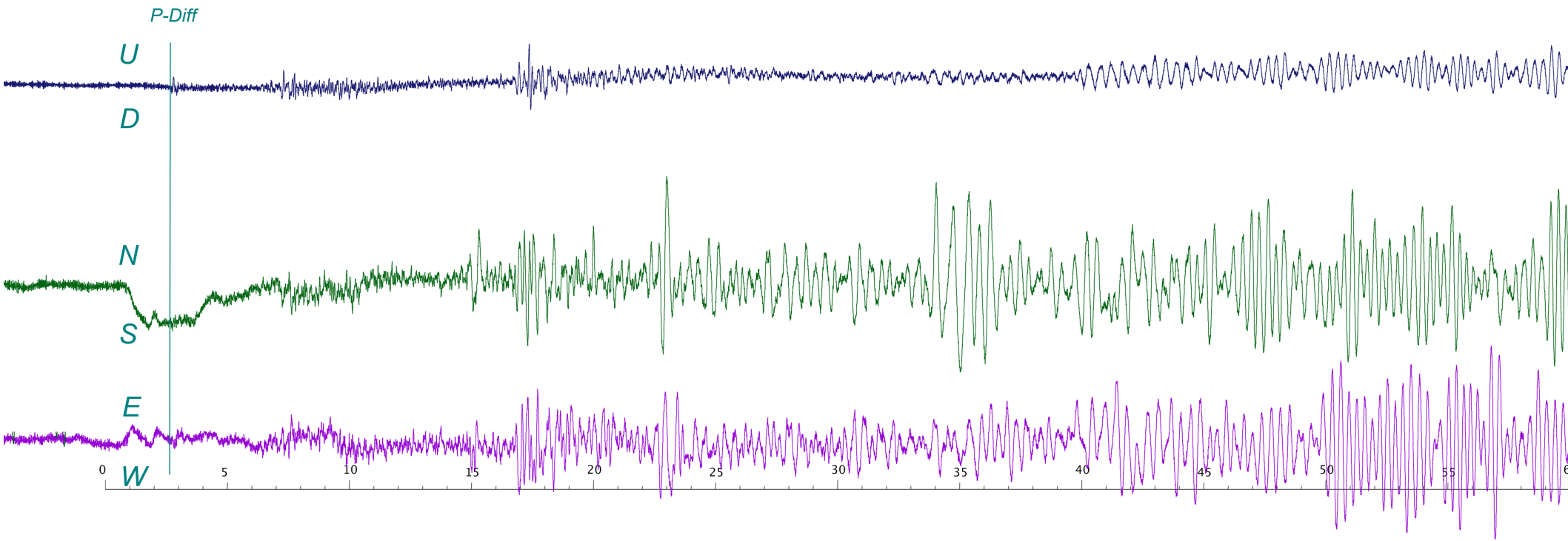
/home/seagull/Desktop/2025_Seis/OKU_2025/2025/07/20.txt











15°53'09.6"N 96°00'28.8"W

15°53'09.6"N 96°00'28.8"W
15.886000, -96.008000



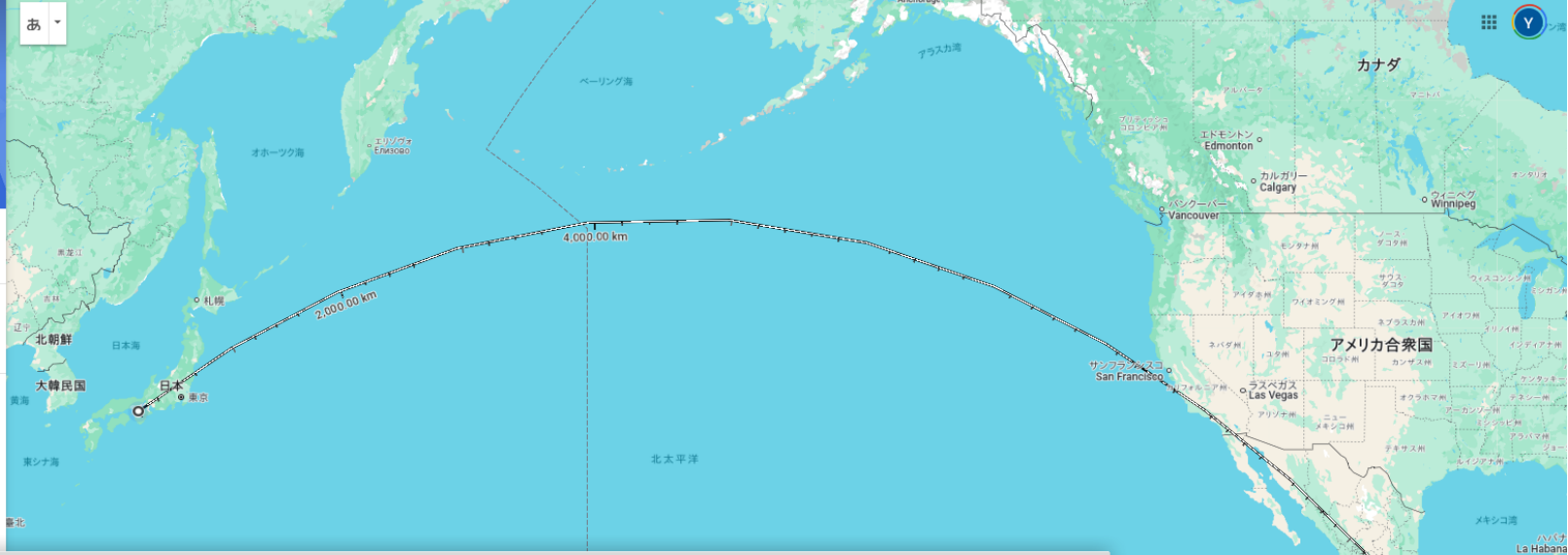
VXPR+9RR シマタン, メキシコ オアハカ

地図に載っていない場所を追加

自身のビジネス情報を追加

ラベルを追加

マップのアクティビティ



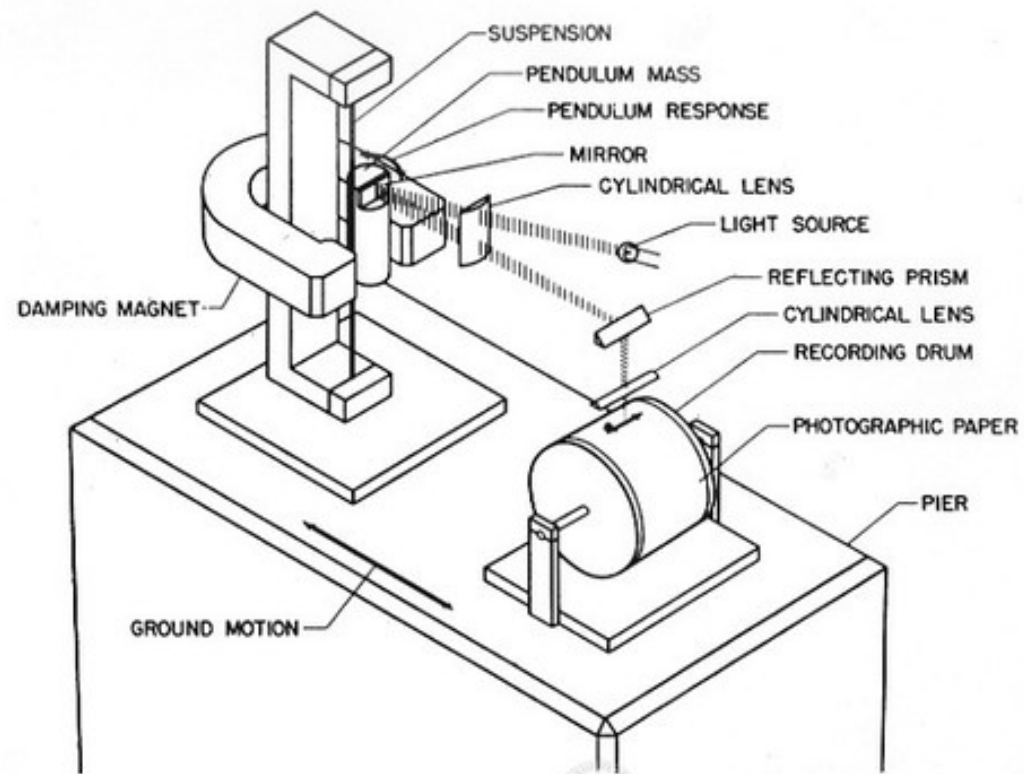
2018-2022_KVIS.xlsx - LibreOffice Calc

ファイル(F) 編集(E) 表示(V) 挿入(I) 書式(O) スタイル(Y) シート(S) データ(D) ツール(T) ウィンドウ(W) ヘルプ(H)



A4: M4 $\sum$ $=K4*(180/PI())$

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
				Lat	Lon			Epicentral dist	Geo-central Angle[Deg]		Angle[Deg.]	Distance[km]	Google Map		
	SAYAMA CITY							0.60224331169	2.3659334274						
	M 7.1 - 37 km W of Atiquipa, Peru	7.1	39 15.768°S	74.709°W	-15.768	-74.709	-0.27520351645	-1.303918031	2.5660418563		147.02336842	16348.252666	16348		
	M 7.4 - 9 km SE of Santa Maria Xadani, Mexico	7.4	20 15.886°N	96.008°W	15.886	-96.008	0.27776300497	-1.675655708	1.9151878294		109.7321796	12201.661661	12205		



Caltech Archives

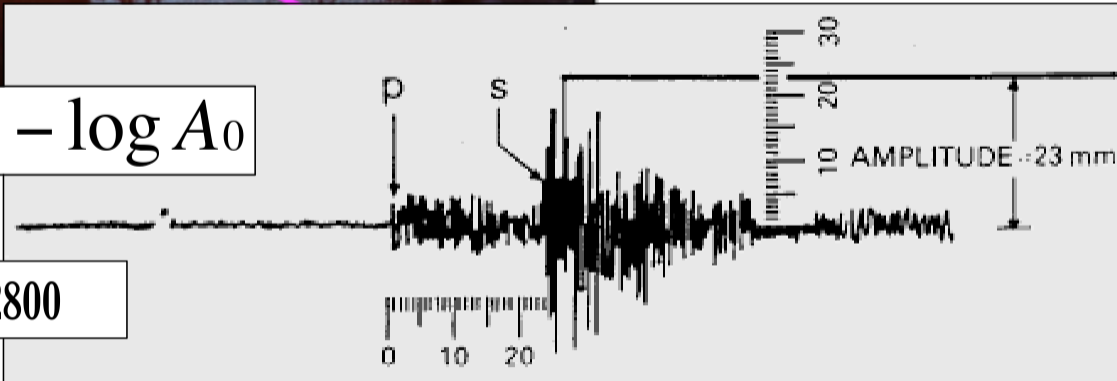
The concept of magnitude was introduced by Richter (1935) measured with the standard Wood-Anderson torsion seismometer (M_L)

Wood - Anderson
operating in TS since 1971



$$M_L = \log A - \log A_0$$

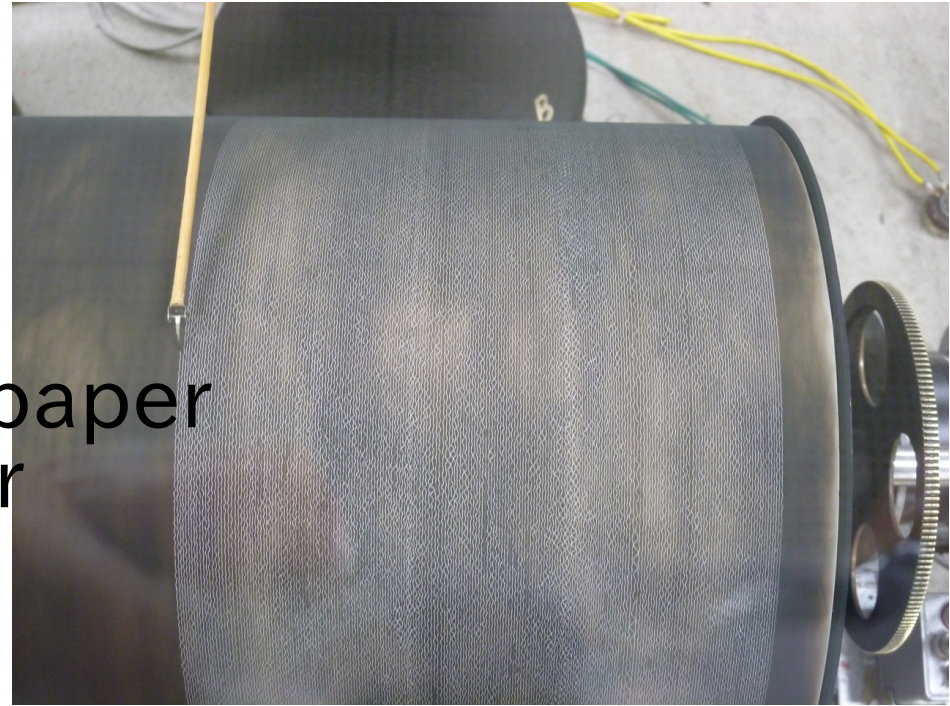
$$T_0=0.8, h=0.8, V=2800$$



Principle of Seismometer

Shaking in Latin

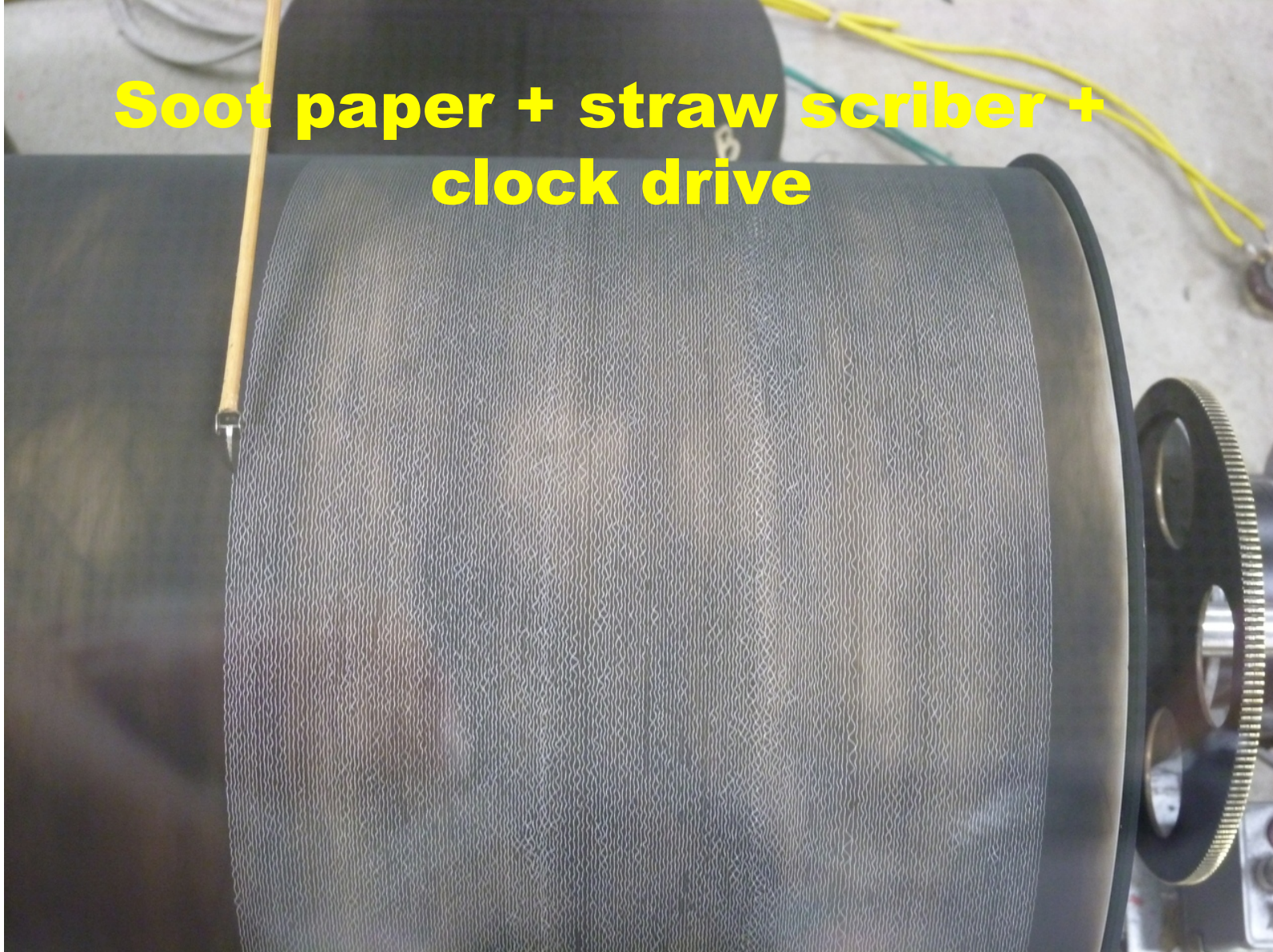
- Fixed mass in shaking
- Relative movements under ground shakings
- Pendulum (Vertical / Horizontal)
- Sensor + Amplifier
 - Mechanical (lever)
 - Electro-magnetic
 - Capacitance
- Recording system
 - Historical: straw and soot paper
Photo paper/Galvanometer
 - Modern: Computer based



Omori type mechanical seismograph (1896) Seismograph museum at ERI (Tokyo Univ.)



**Soot paper + straw scribe +
clock drive**



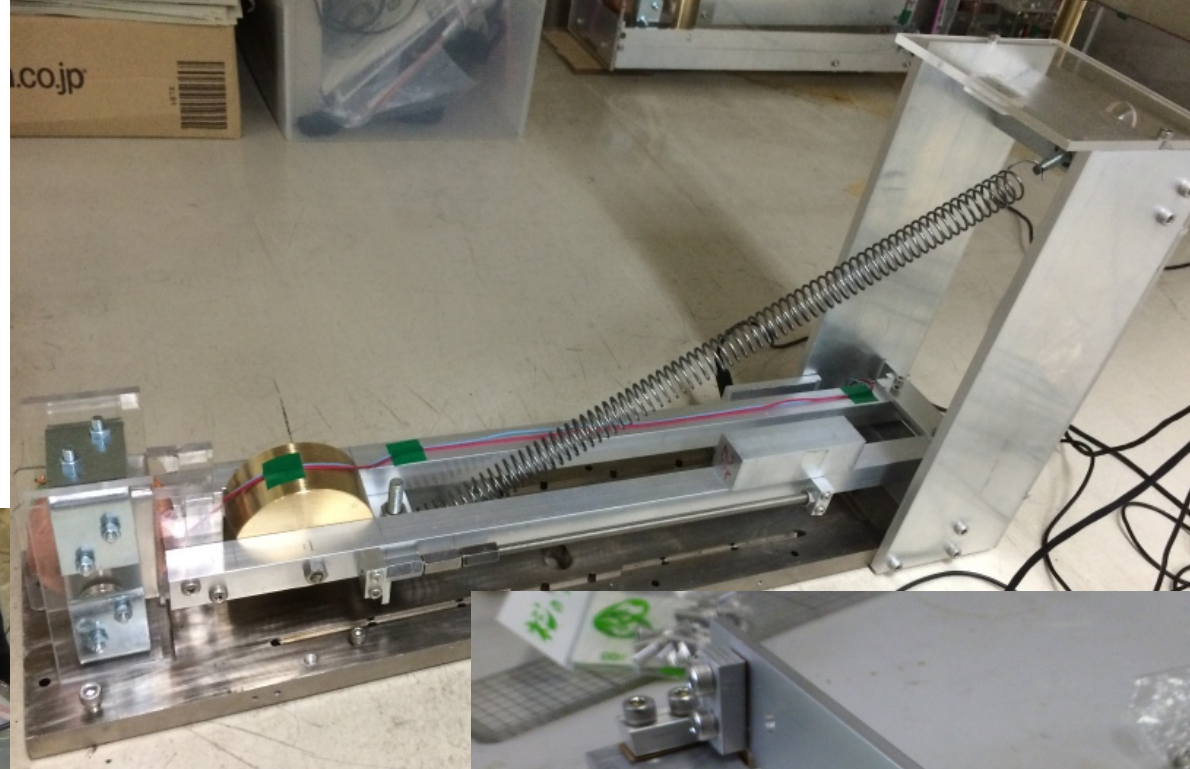
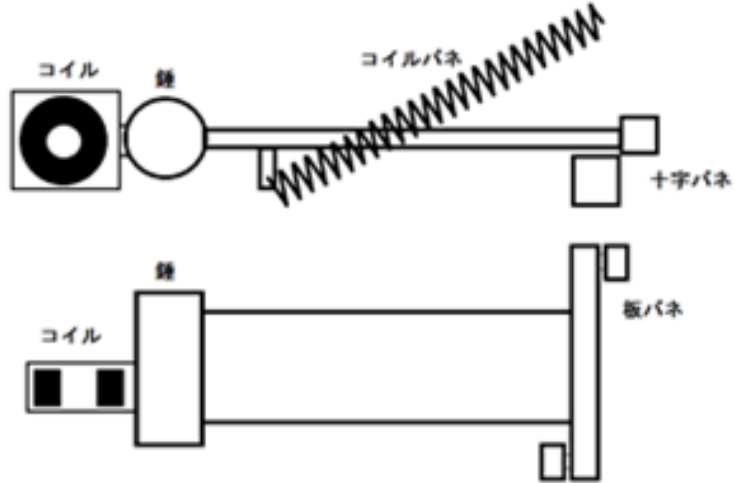


Off course these system are too old fashioned!
However old system is completely visible and comprehensive!

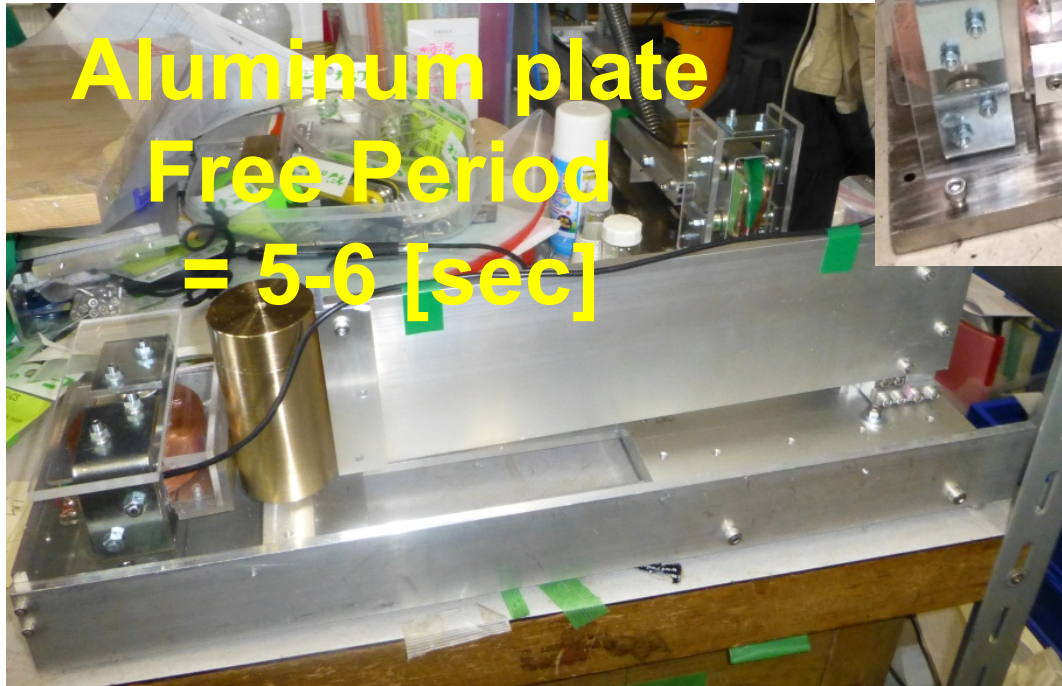


**Modern seismograph systems at
Matsushiro seismic observatory
(Japan Meteorological Agency)**





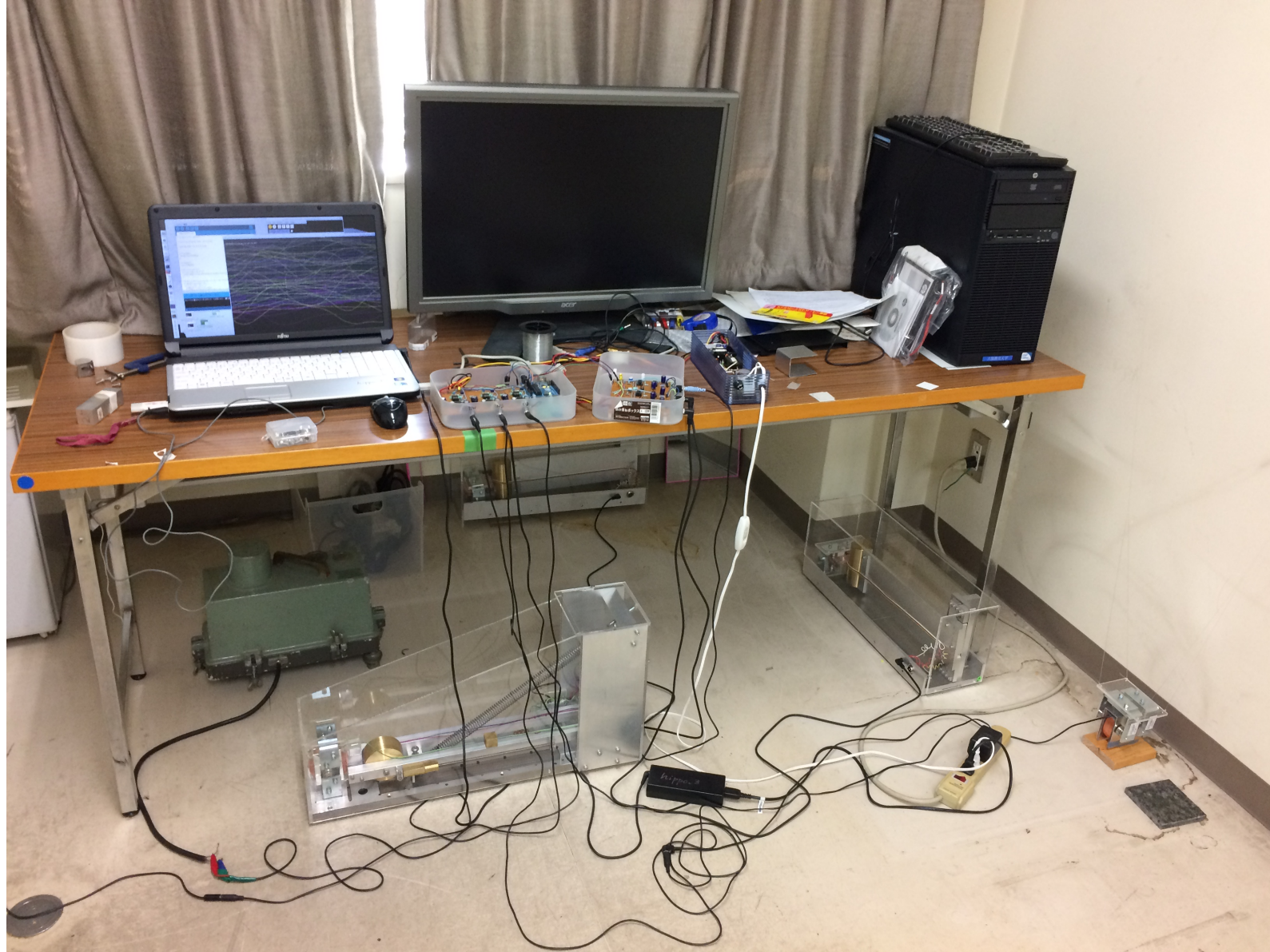
Aluminum plate
Free Period
= 5-6 [sec]



Cross bar spring

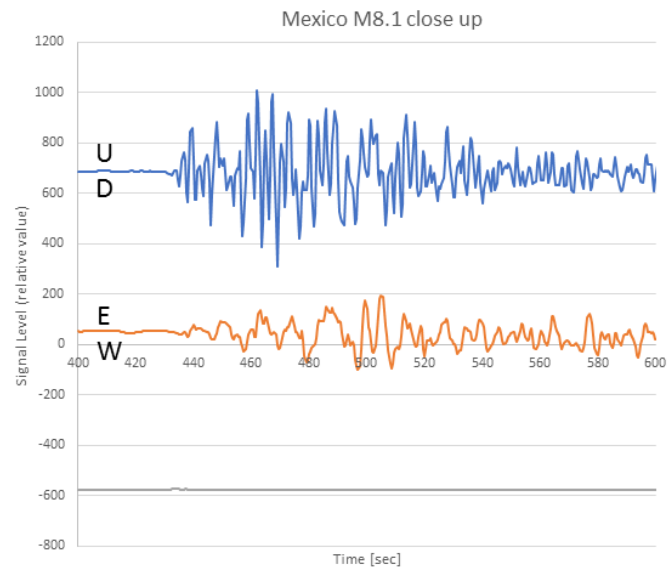


柏原B棟2017

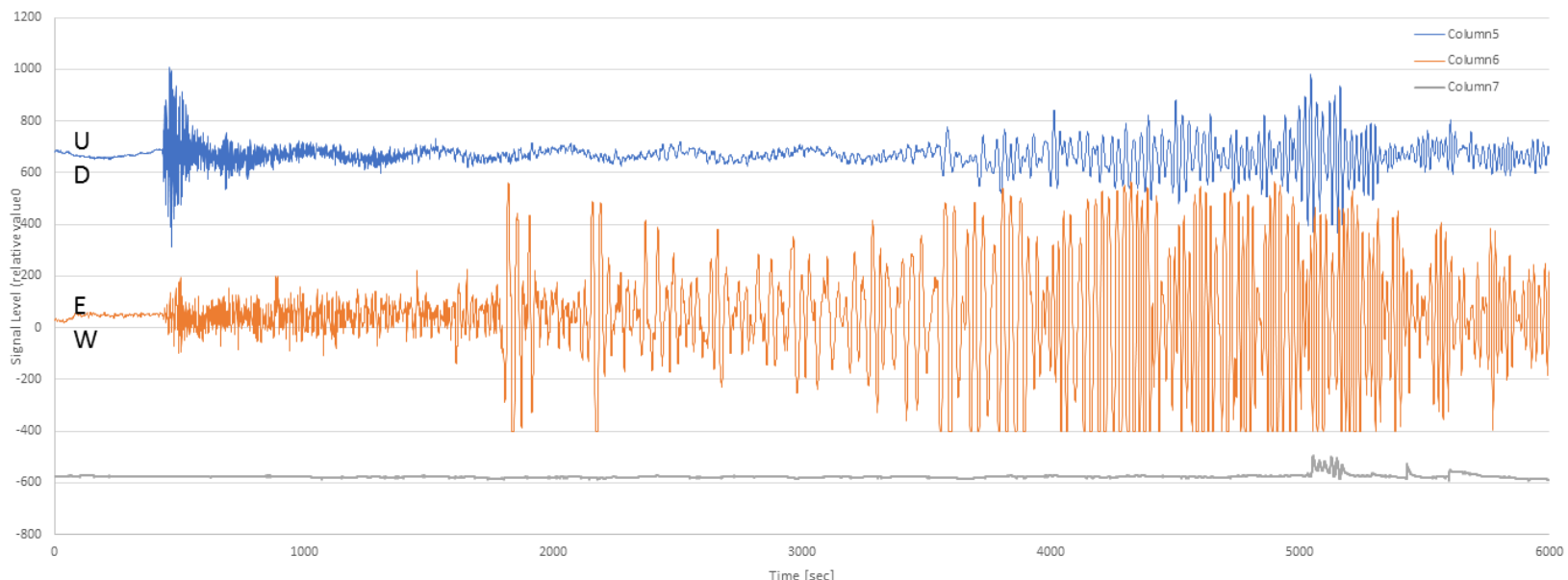


KVIS,Thailand 2017

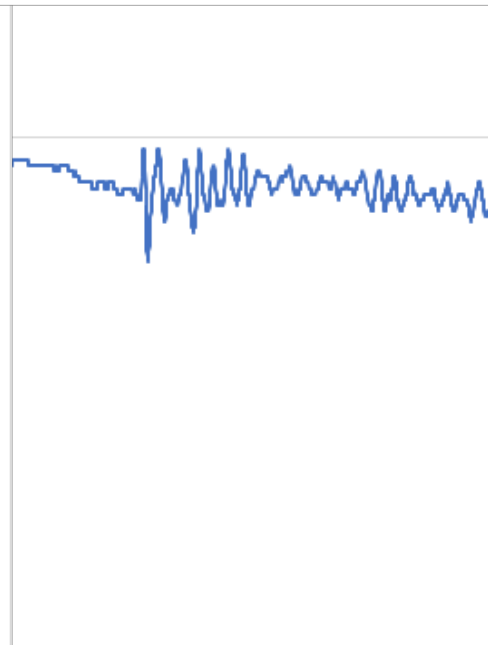
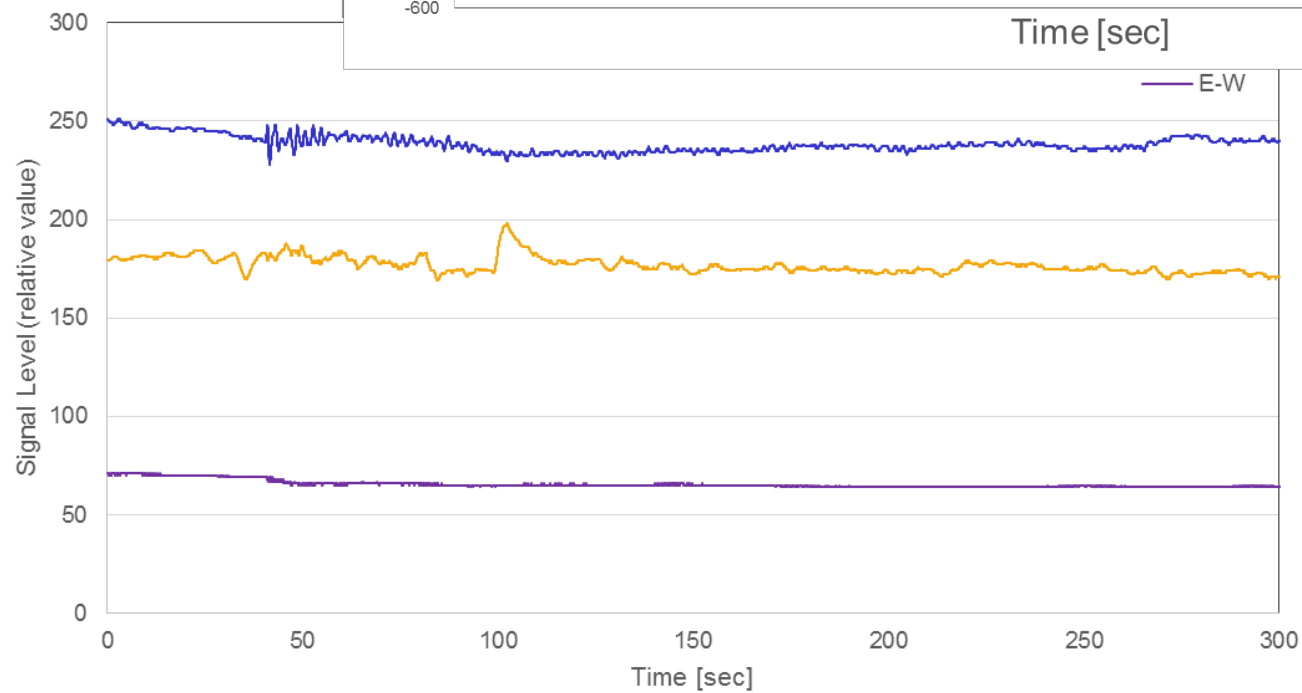
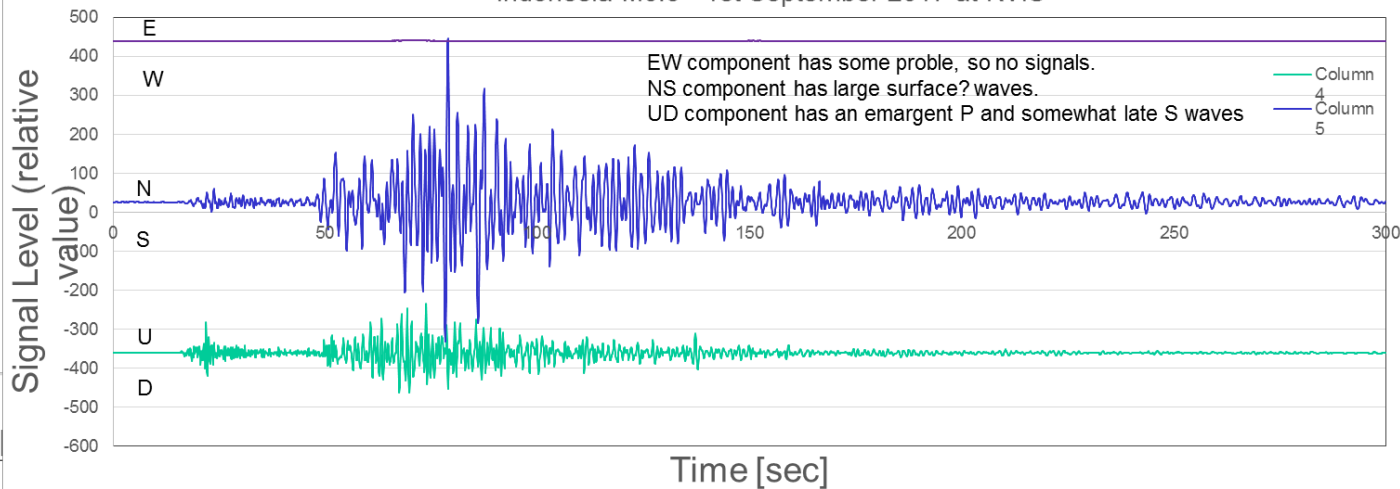




Mexico M8.1 8th Sep.2017



Indonesia M6.3 1st September 2017 at KVIS



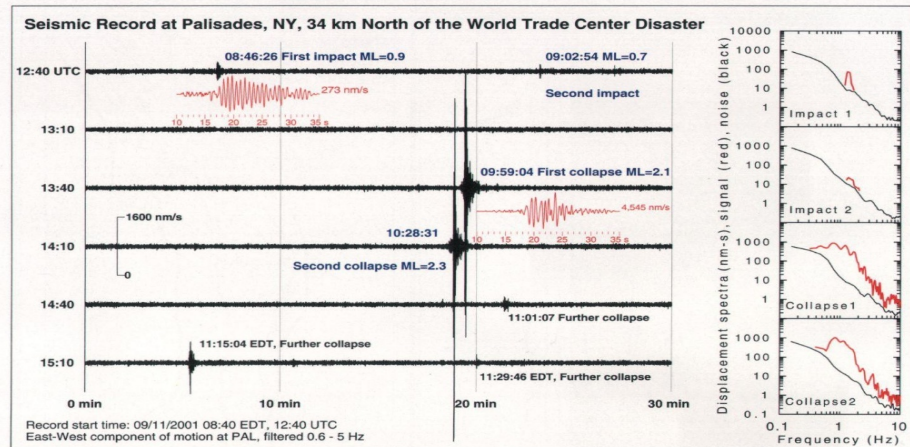


Fig. 1. Seismic recordings on E-W component at Palisades for events at World Trade Center (WTC) on September 11, distance 34 km. Three hours of continuous data shown starting at 08:40 EDT (12:40 UTC). Data were sampled at 40 times/s and passband filtered from 0.6 to 5 Hz. Two largest signals were generated by collapses of towers 1 and 2. Eastern Daylight Time (EDT) is UTC minus 4 hours. Expanded views of first impact and first collapse shown in red. Displacement amplitude spectra in nm-s from main impacts and collapses shown at right. Sampling is done for 14-second time windows starting about 17 s after origin time. Note broad-band nature of spectra for collapses 1 and 2. Their signals are similar with a correlation coefficient of about 0.9 as are those for two impacts.

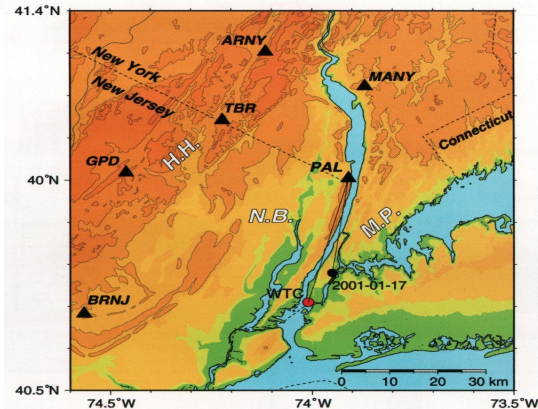


Fig. 2. Seismograph stations and topography for greater New York City area. Solid triangles indicate stations that recorded events at WTC (solid red circle); black circle, epicenter of earthquake of January 17, 2001. N.B. denotes Newark Basin; H.H., Hudson Highlands; M.P., Manhattan Prong.

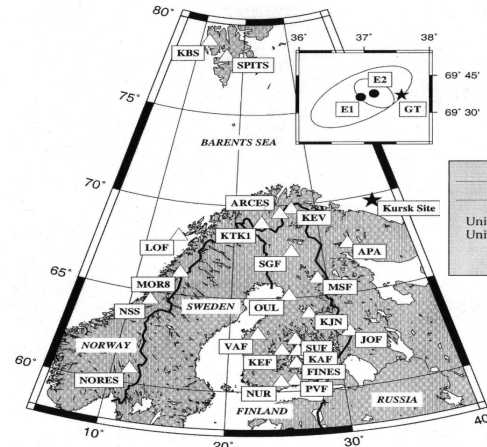


Fig. 3. Locations of regional distance seismic stations which recorded the Kursk events. The stations are a combination of short-period arrays, vertical short-period instruments, three component short-period instruments, and three component broadband instruments. The inset shows our locations and error ellipses for the precursory event (E1) and the main event (E2). The actual position (GT) of the downed sub is indicated by the star.

Source	Latitude, °N	Longitude, °E	Origin Time	m_b	M_L
University of Helsinki	69.67	37.53	07:30:41.9	—	3.0
University of Bergen	69.58	38.03	07:30:42.6	3.8	3.3
NORSAR	69.67	37.25	07:30:42.0	3.5	—
PIDC	69.58	37.92	07:30:42.2	3.4	4.2

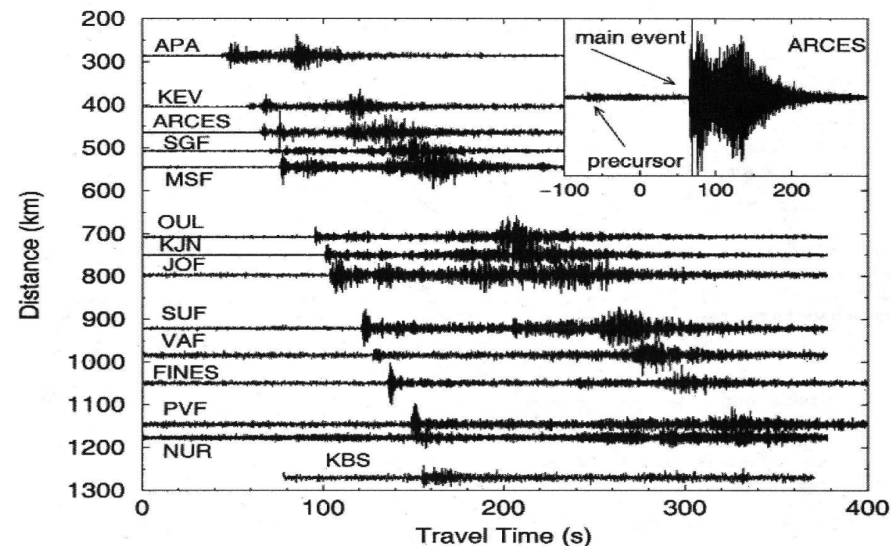
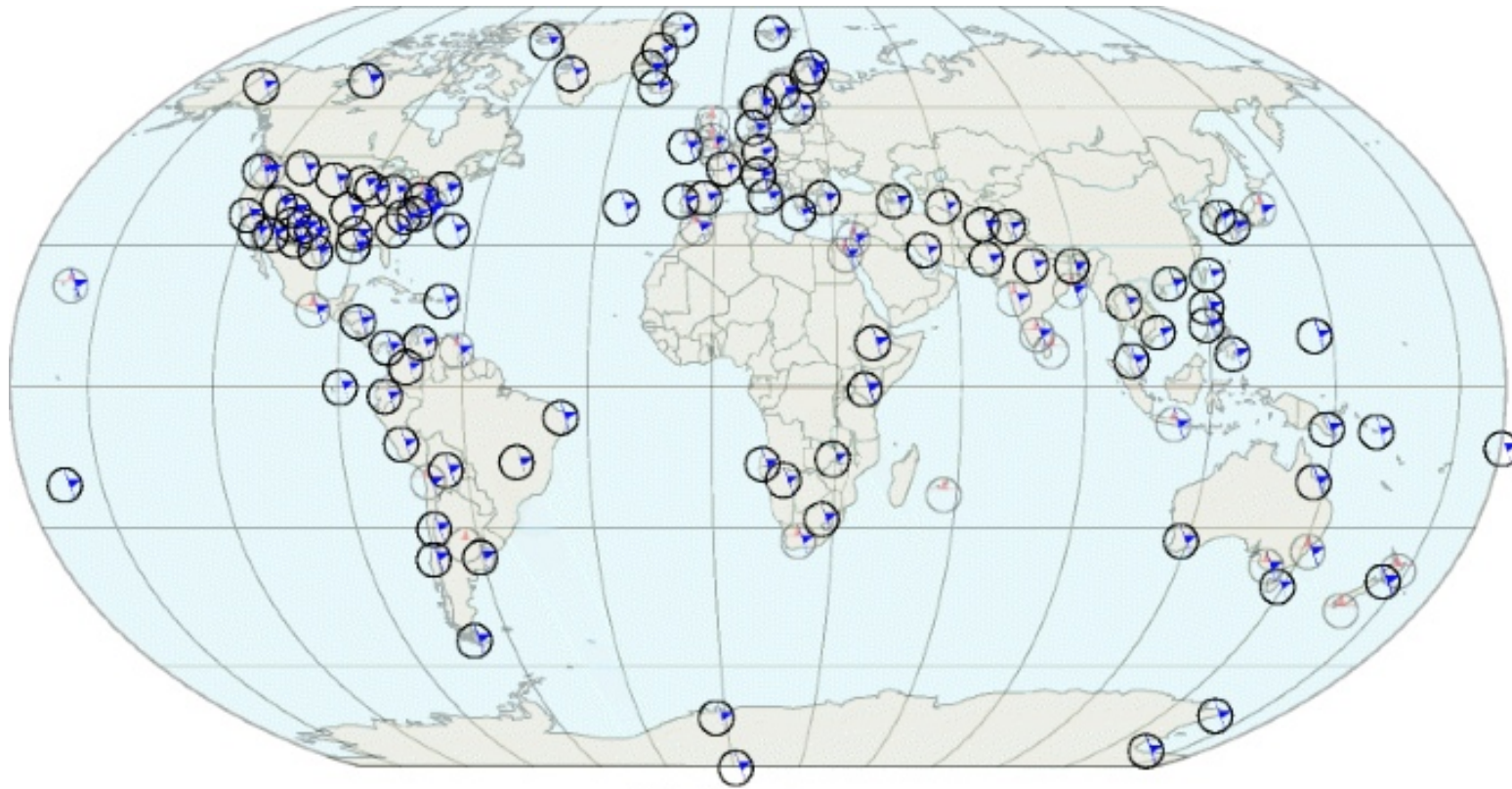


Fig. 4. Vertical component record section of the main Kursk event. Each trace has been highpass filtered and normalized to a common scale. P_n and L_s phases are clearly visible at all distances although their ratio, and the ratio of compressional to shear energy in general, has large variability. The inset shows the relative size of two Kursk events from an element of the ARCES array.

WWSSN stations



Milne Network



World-Wide Standardized Seismograph Network

<https://link.springer.com/rwe/10.1007/978-90-481-8702->

Film case Seismometer

1007

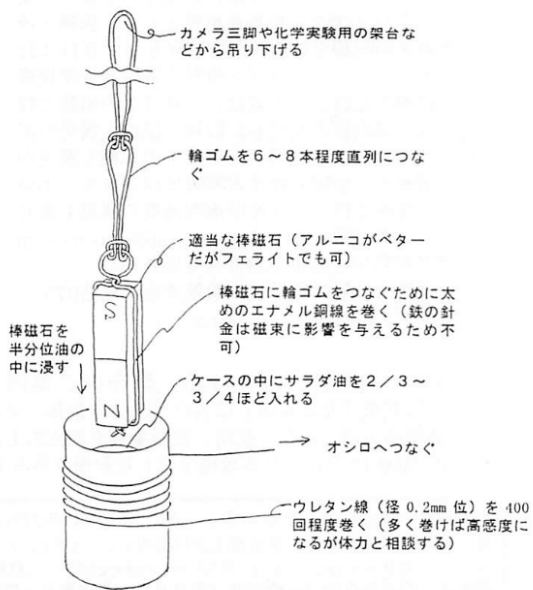


図2 フィルムケース地震計センサー部の組み立て

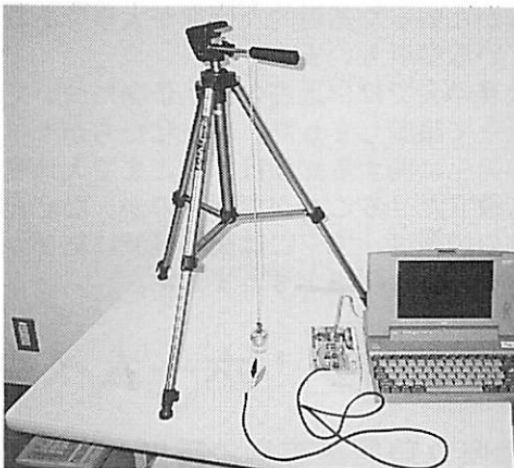


図1 フィルムケース地震計全景

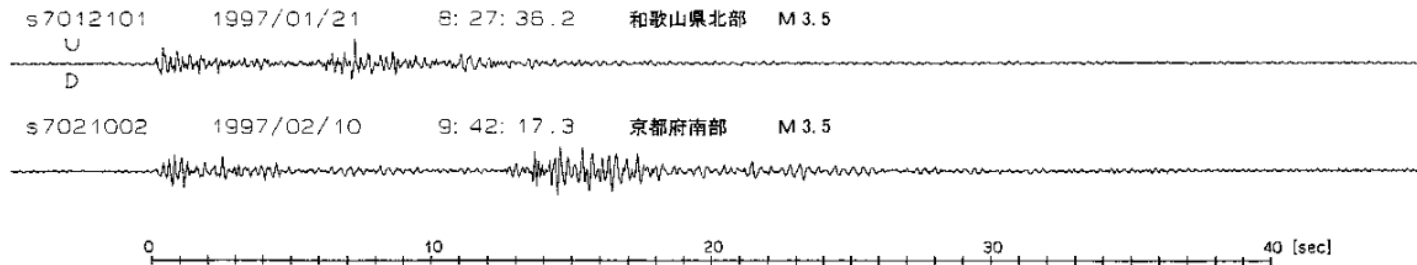


図1 フィルムケース地震計で記録した地震波形

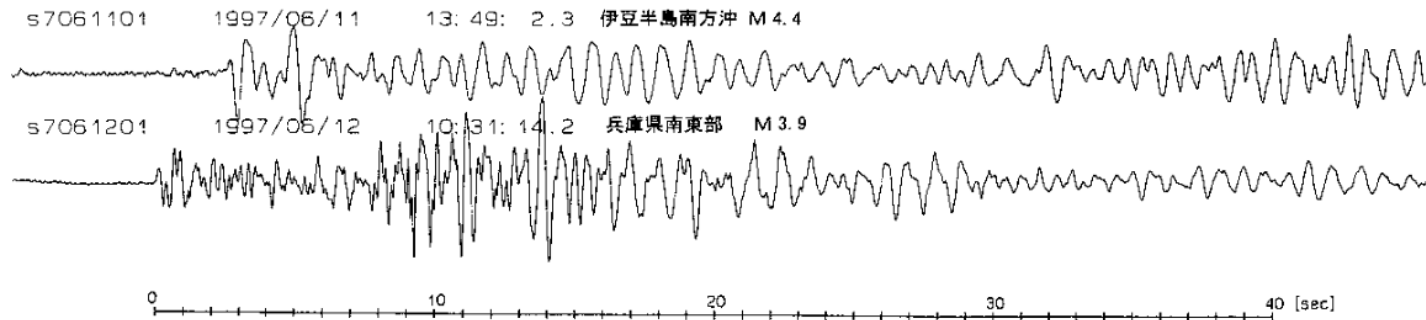
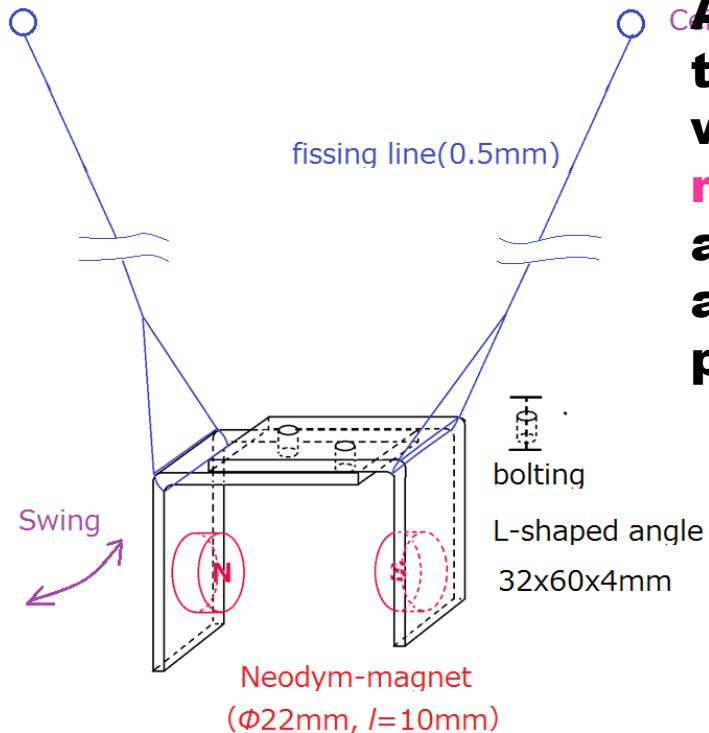


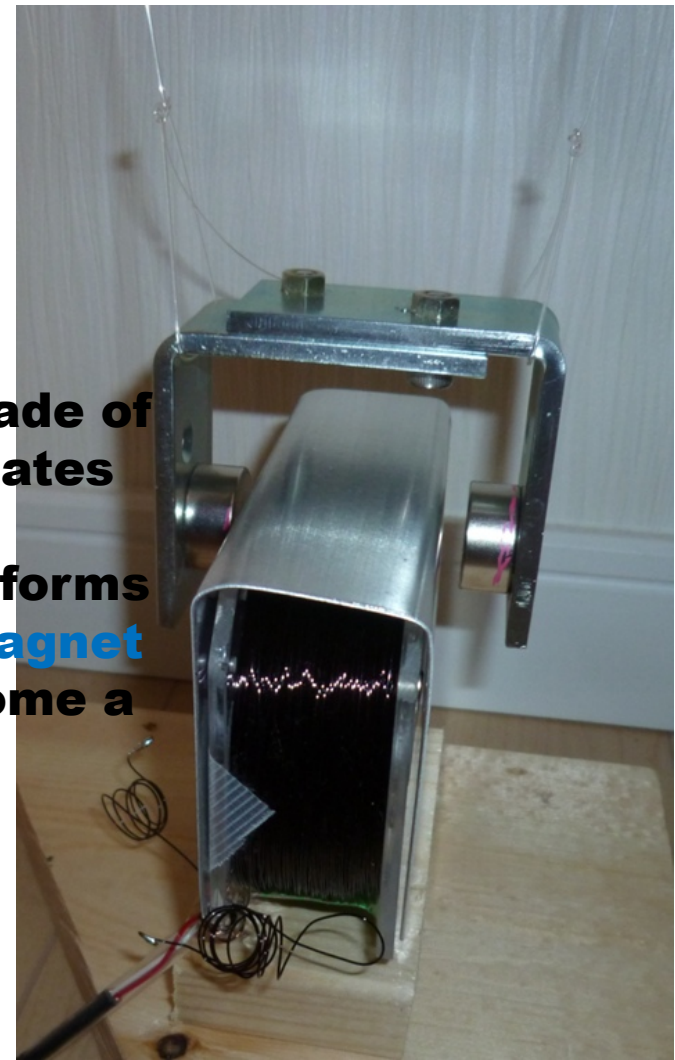
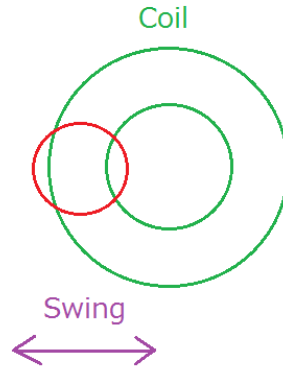
図3 図2の改良センサーによる記録波形（震源は気象庁速報値による。図はいずれも文献より引用）

A simple **bifilar suspension** is used for the horizontal pendulum.

An aluminum plate covering coil is used as a “dumper”



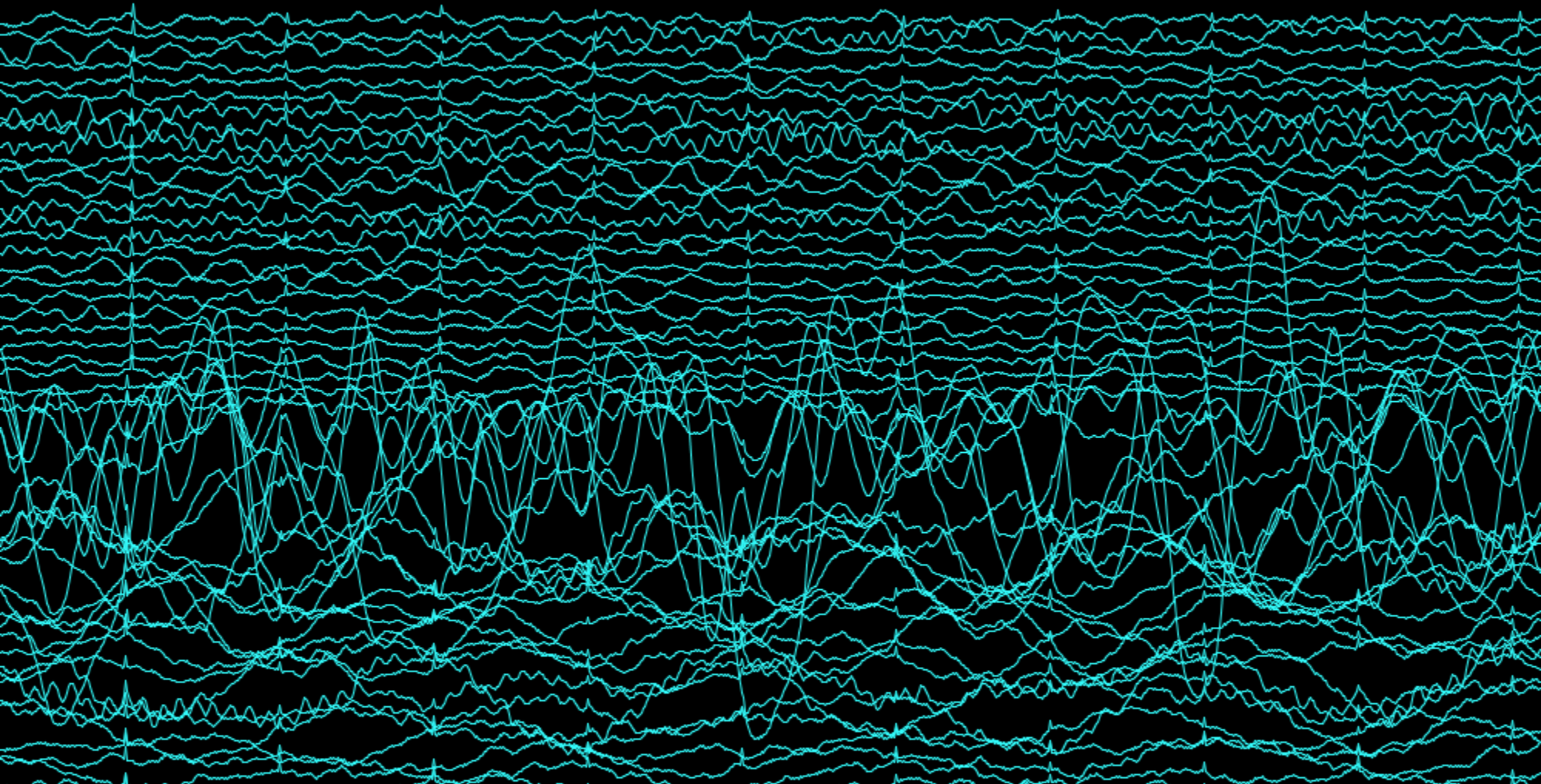
A magnetic circuit made of two L shaped steel plates with two columnar **neodymium magnets** forms a **U-shaped bipolar magnet** as a whole, also become a pendulum's weight.



2015/09/02/Time=16_03_29_iFS

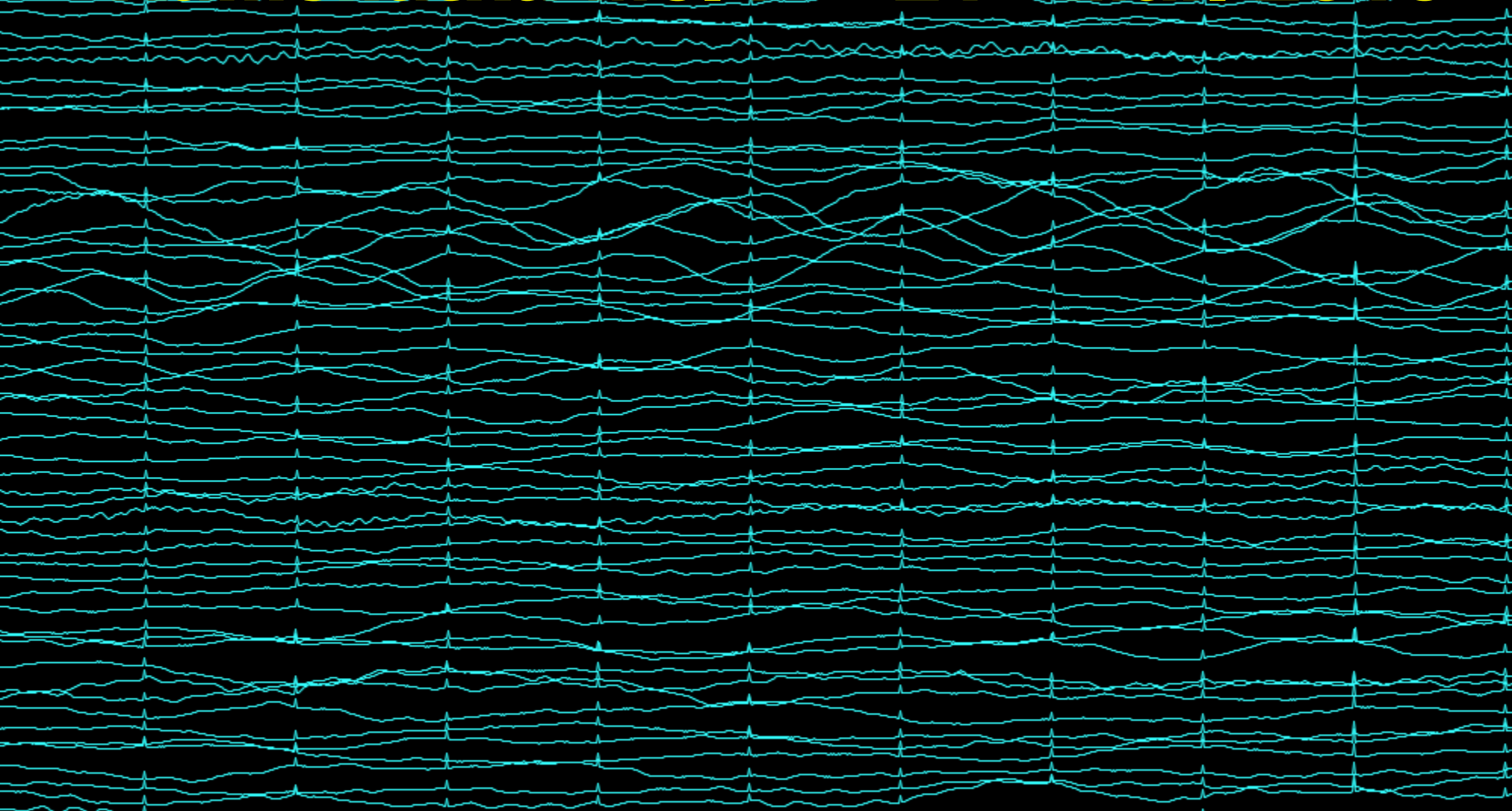
Shikoku Off M4.6 2nd Sep. 2015

Recorded by the prototype



2016/03/21 Time=07:50:21 iFS

Kamchatka M6.4 21th Mar. 2016



Hardware: Solder less Bread board

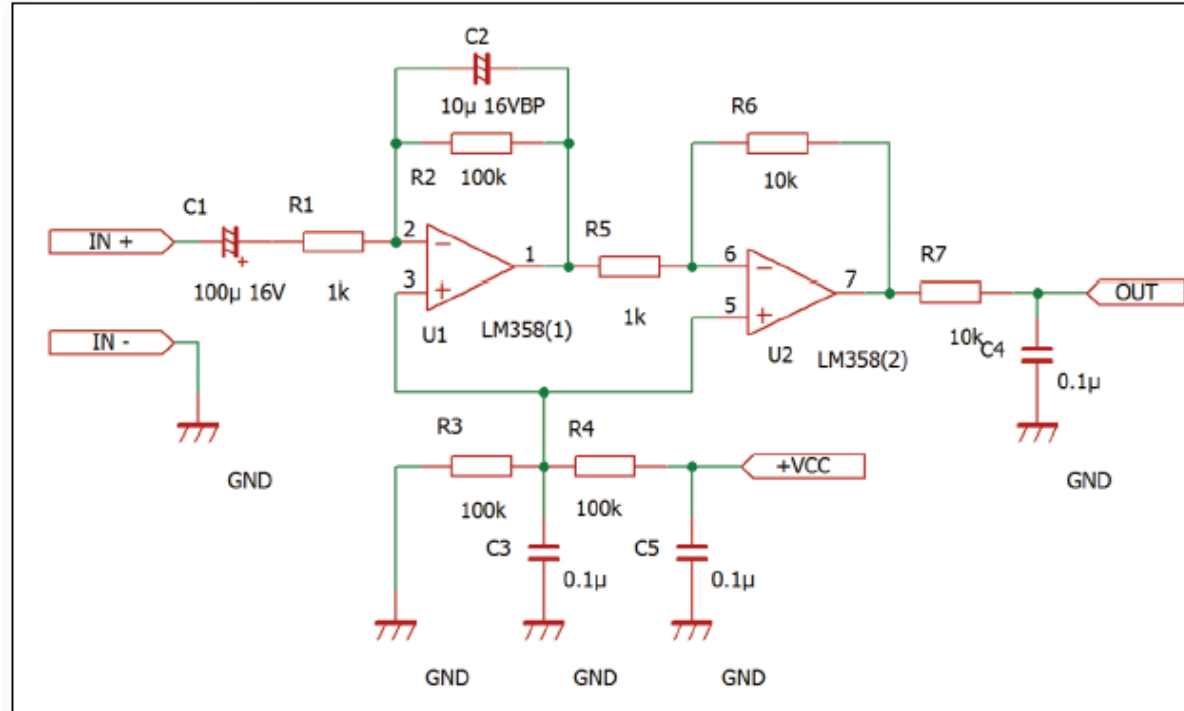
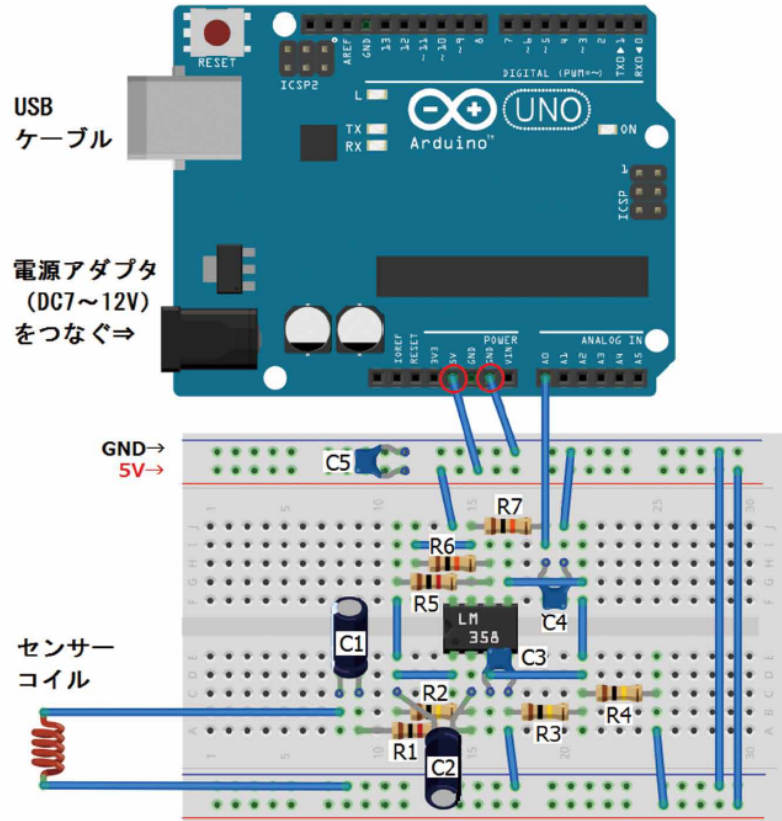


図1 アンプの回路図 (OPアンプの電源は省略、8番ピンに5V、4番ピンがグラウンド)

図2 ブレッドボードの配線とArduinoとの接続

Software: Arduino IDE + Processing

```
seism_demo | Arduino 1.0.5
ファイル 編集 スケッチ ツール ヘルプ

seism_demo
// seism_demo

const int accel_pin[] = { 0, 1, 2 };

int accel_val[] = { 0, 0, 0 };

void setup() {
  Serial.begin( 9600 );
}

void loop() {
  byte buffer[2];

  // AD convert for 1-ch
  for ( int i = 0; i < 1; i++ ) {
    accel_val[i] = analogRead( accel_pin[i] ); // read pin[i]
  }

  // Data transfer: if processing send one byte character * to Arduino
  if ( Serial.available() > 0 ) {
    for ( int i = 0; i < 1; i++ ) {
      buffer[0] = byte( accel_val[i] );
      buffer[1] = byte( accel_val[i] >> 8 );
      Serial.write( buffer, 2 );
    }
    Serial.read(); // take off * character
  }
}
```

1 Arduino Uno on COM9

```
seism_demo | Processing 3.0
ファイル 編集 スケッチ Debug ツール ヘルプ

seism_demo
31 String datastr;
32 String datetimestr;
33 String format;
34
35 void setup() {
36   size(1000,720); // display size
37   strokeWeight( 1 ); // line width
38   background( 0 ); // clear display
39   port = new Serial(this, Serial.list()[1], 9600); // set up port for the first serial
40   frameRate(100); // sampling rate/sec
41   stroke(255);
42   // smooth();
43 }
44
45 void draw() {
46
47   // initialize
48   if (sflg==0){
49     delay(1000);
50     port.write( '*' );
51     background(0);
52     t=0;
53     tt=0;
54     sflg=1;
55     port.write( '*' );
56   }
57
58   // file init.
59   if (t == 0){
60     datetimestr = year()+"/"+nf(month(),2)+"/"+nf(day(),2)+"/Time="+nf(hour(),2) + "_"
61     output = createWriter(datetimestr+".dat");
62     text( datetimestr,10,35);
63     port.write( '*' );
64   }
65
66   // time mark
67   s = second();
68   if (s == ps)
```

You are running Processing revision 0246, the latest build is 0255.

Console Errors

Make Your Own Seismograph!

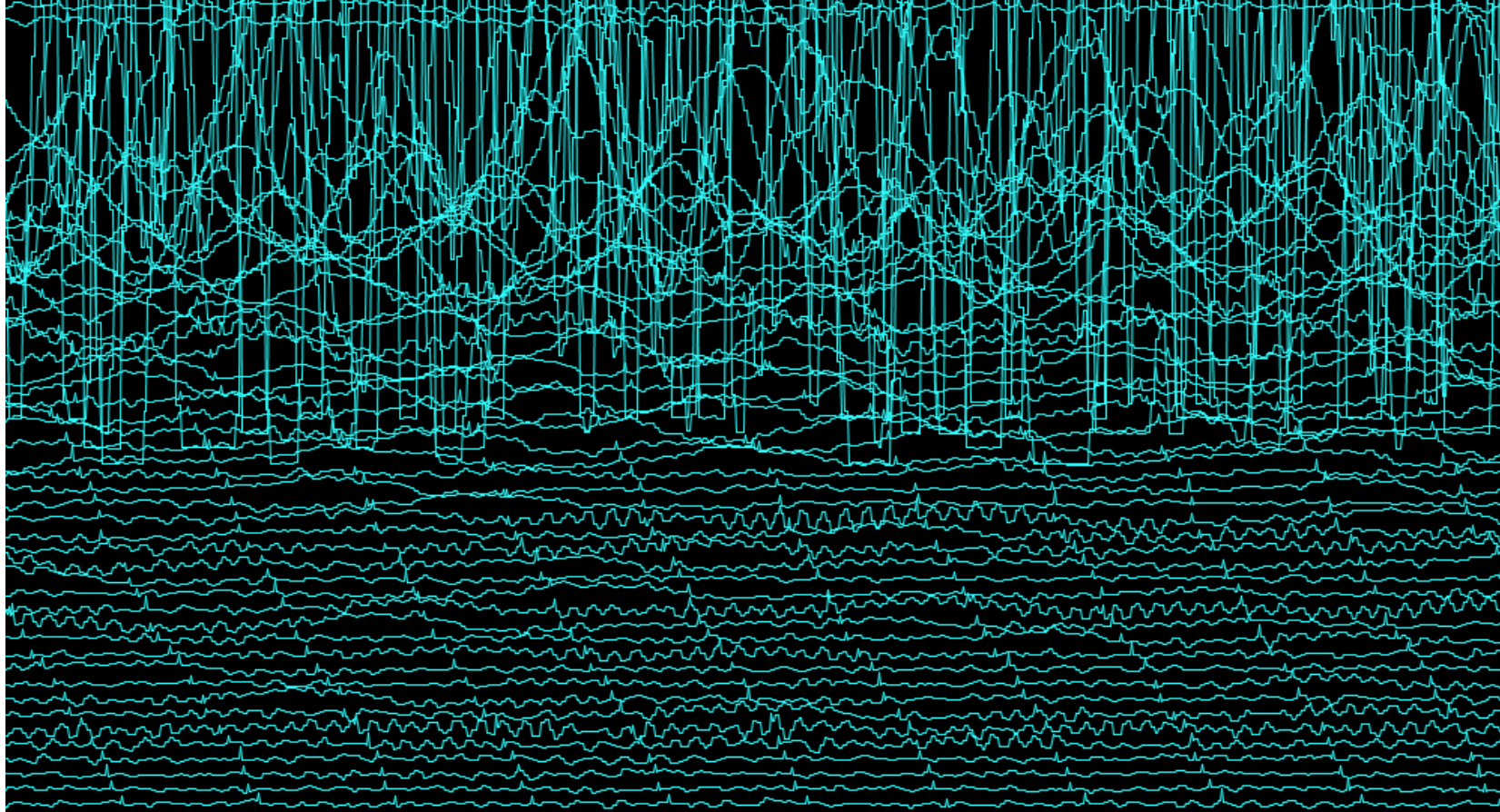
- **The recording system**
: PC, Raspberry Pi, M5Stack,
etc.
- **So, If you prepare your own made
pendulum + sensor, you can make your
own seismograph system.**
- **Let us show you an example made by
our student.**

Student's horizontal pendulum



2016/11/19 Time=31:50:50 JST

S of Wakayama Pref. M5.4 19th Nov.2015

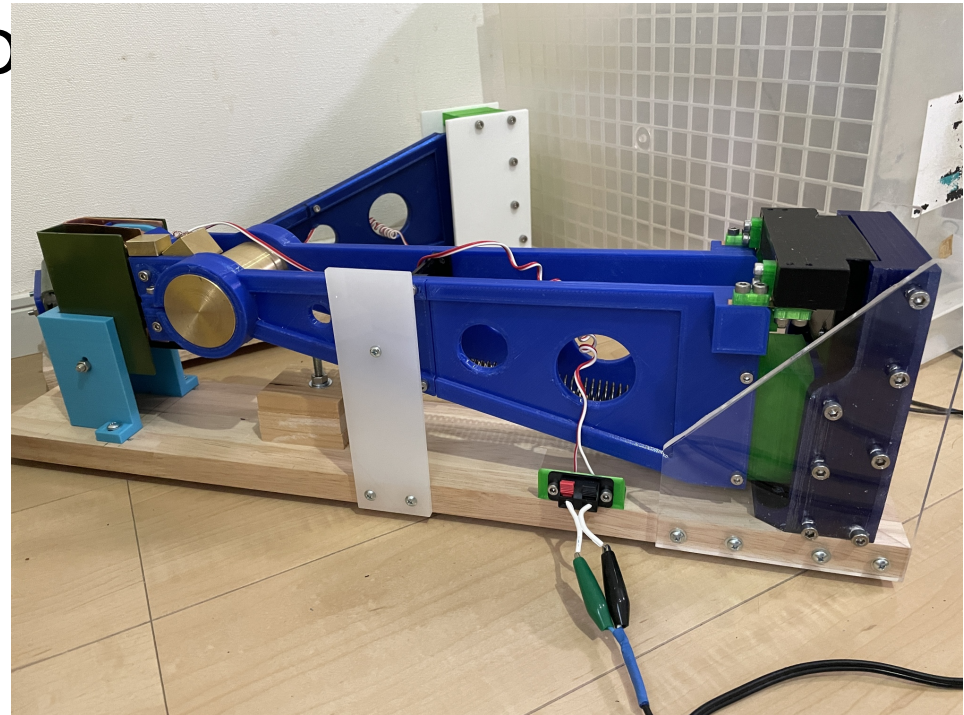


My New Seismograph

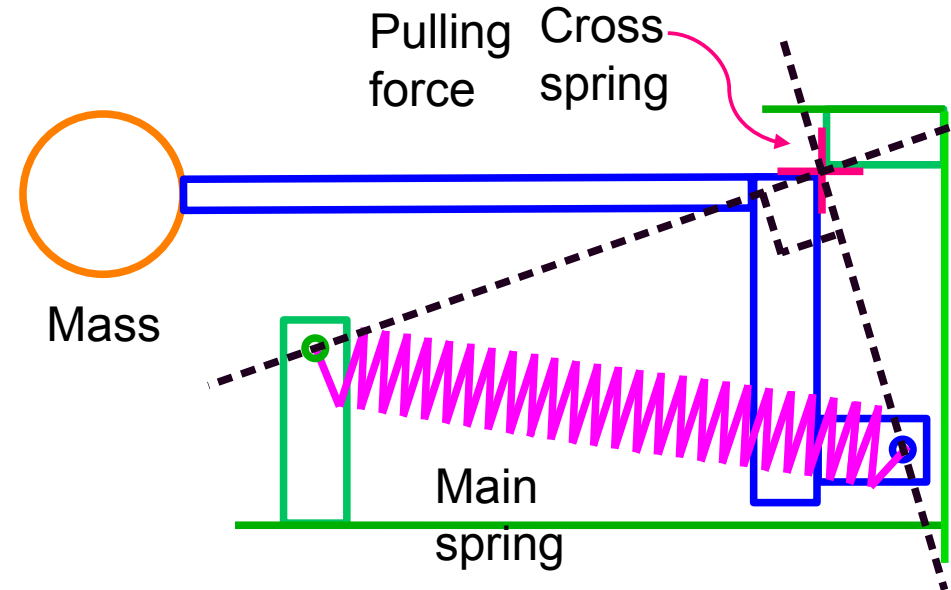
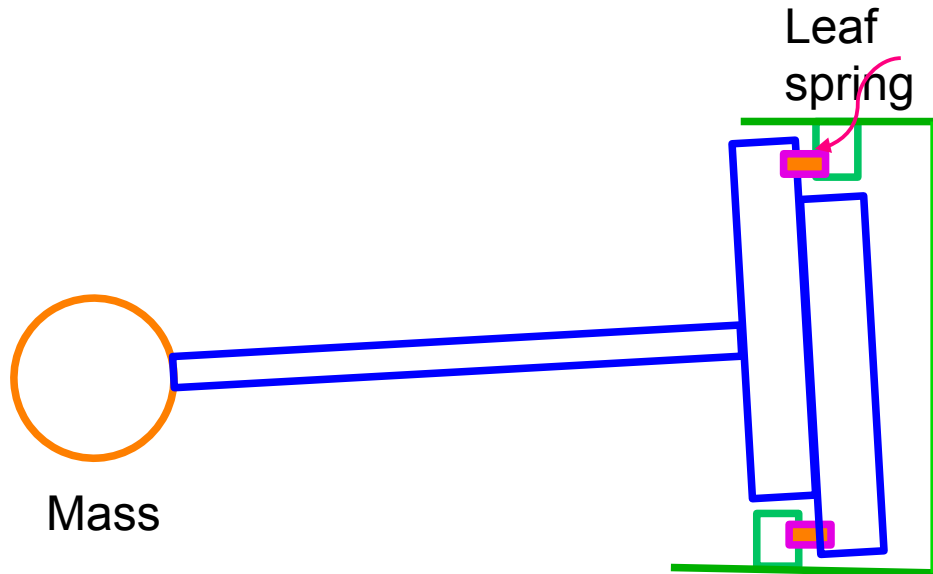
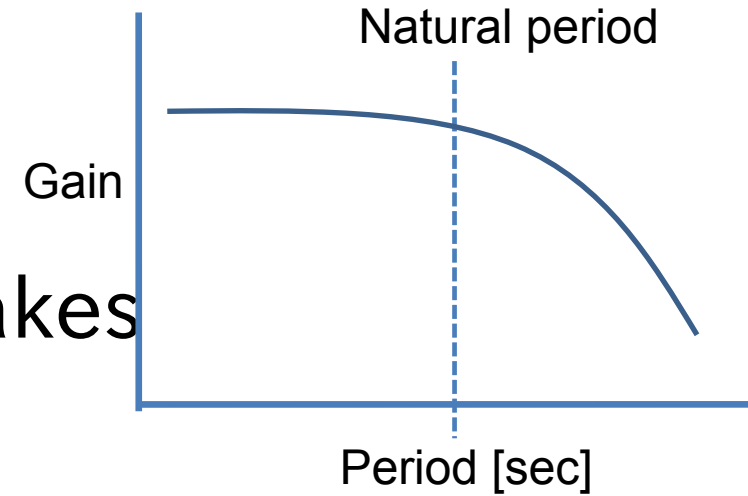
- Horizontal: Pascwitz type (Swing-gate pendulum)



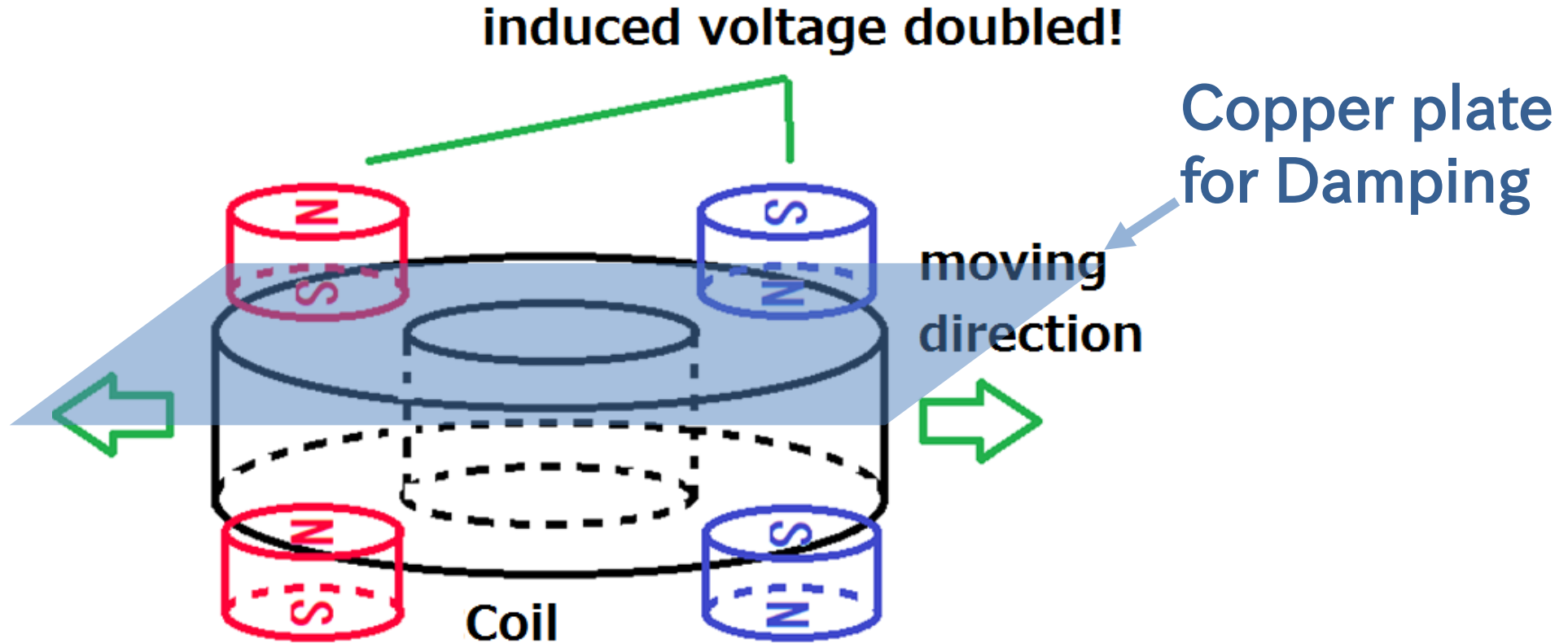
(mo



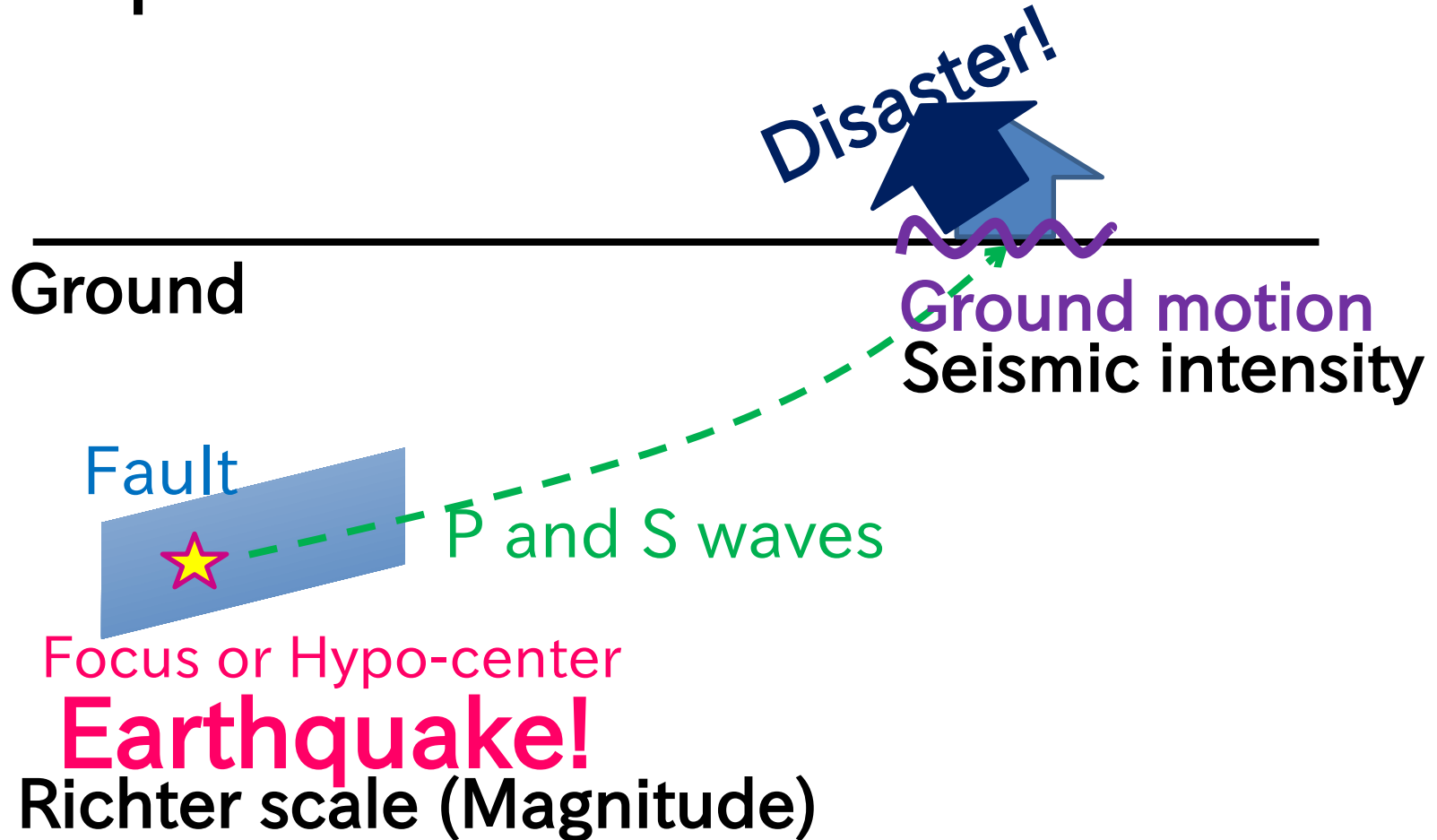
- Long-period pendulum
- Longer period ->
more oversea earthquakes



Structure of Electromagnetic sensor



Earthquake: cause and result



自宅の自作地震計

