VESPA(Velocity Spectral Analysis) Tutorial

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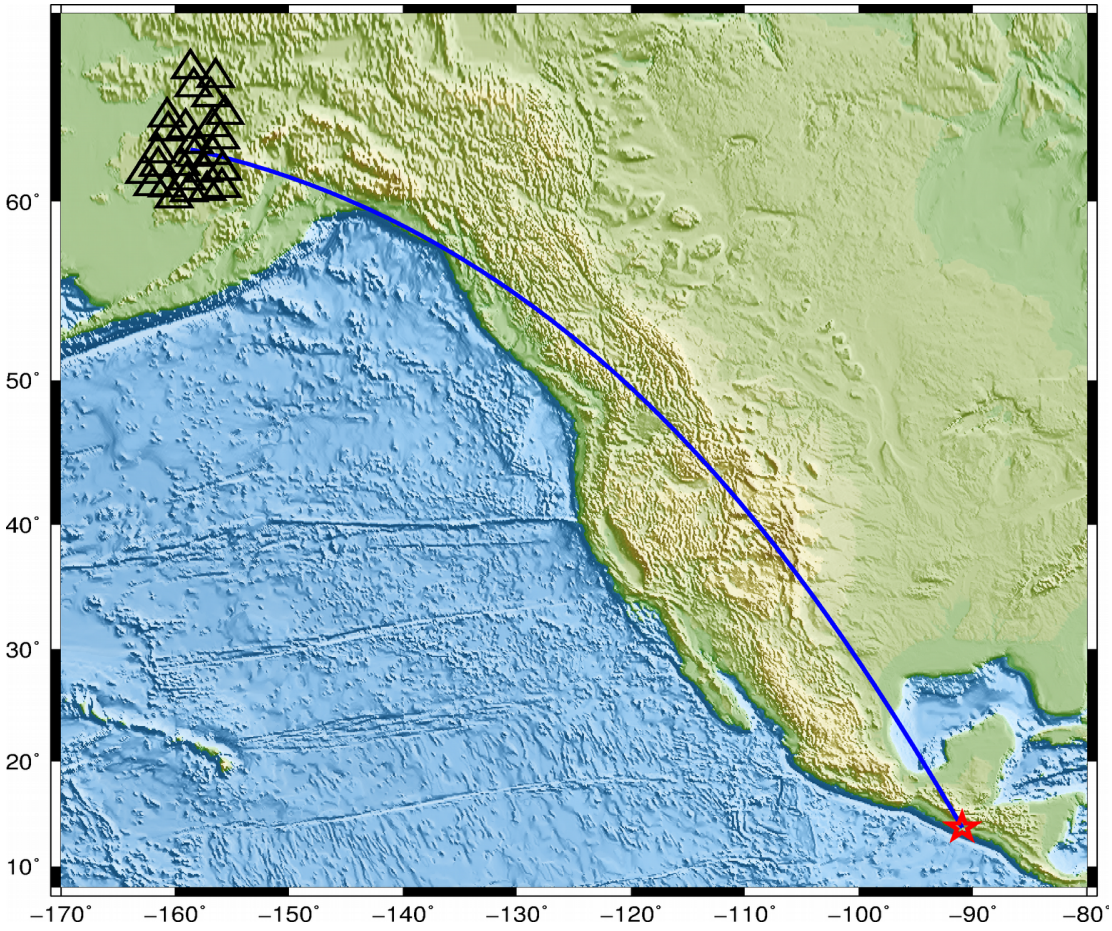
This tutorial is to let readers simply understand how my program works and hope you get something new with it. Especially, here, this program comes with NO WARRANTY, to the extent permitted by law.

1. Parameters of this program

```
++    USAGE: vespa <filelist> <t1> <t2> <f1> <f2> <ID:slow/baz> <slow/baz> <slow_low/baz_low> <slow_high/baz_high> <step_len> <Nth_root> <output>    ++
++           return output_results of 3 columns: col1: time; col2: slowness/backazimuth col3: amplitude                                          ++
++           <filelist>           [1]  file containing every SAC format file                                                                  ++
++           <t1>                 [2]  beginning time of executing Velocity Spectral Analisys                                                 ++
++           <t2>                 [3]  ebding time of executing Velocity Spectal Analysis                                                     ++
++           <f1>                 [4]  low limitation of corner frequency of bandpass filter                                                  ++
++           <f2>                 [5]  high limitation of corner frequency of bandpass filter                                                 ++
++           <ID:slow/baz>        [6]  "slow" or "baz", which means fix slowness/baz and scan baz/slowness                                    ++
++           <slow/baz>           [7]  fixed slowness/backazimuth                                                                             ++
++           <slow_low/baz_low>   [8]  low limitation of scanning sloness or backazimuth                                                      ++
++           <slow_high/baz_high> [9]  high limitation of scanning slowness or backazimuth                                                    ++
++           <step_len>           [10] step length of scanning slowness/backazimuth                                                           ++
++           <Nth_root>           [11] Nth root slant-stacking, here specially, N consistant with 1 means linear stacking                     ++
++           <output>             [12] file saving outputting results: col1: time col2: slowness/baz col3: amplitude                          ++
++                                ATTENTION!!! Executing VESPA requires SAC(Seismic Analysis Code) to filter with bandpass                    ++
++                                             Executing plot.sh requires GMT(the Generic Mapping Tools) with primary version 5,here 5.3.1    ++
```

2. An example of executing this programm

First the information of this earthquake event is given as blow, see fig 1.

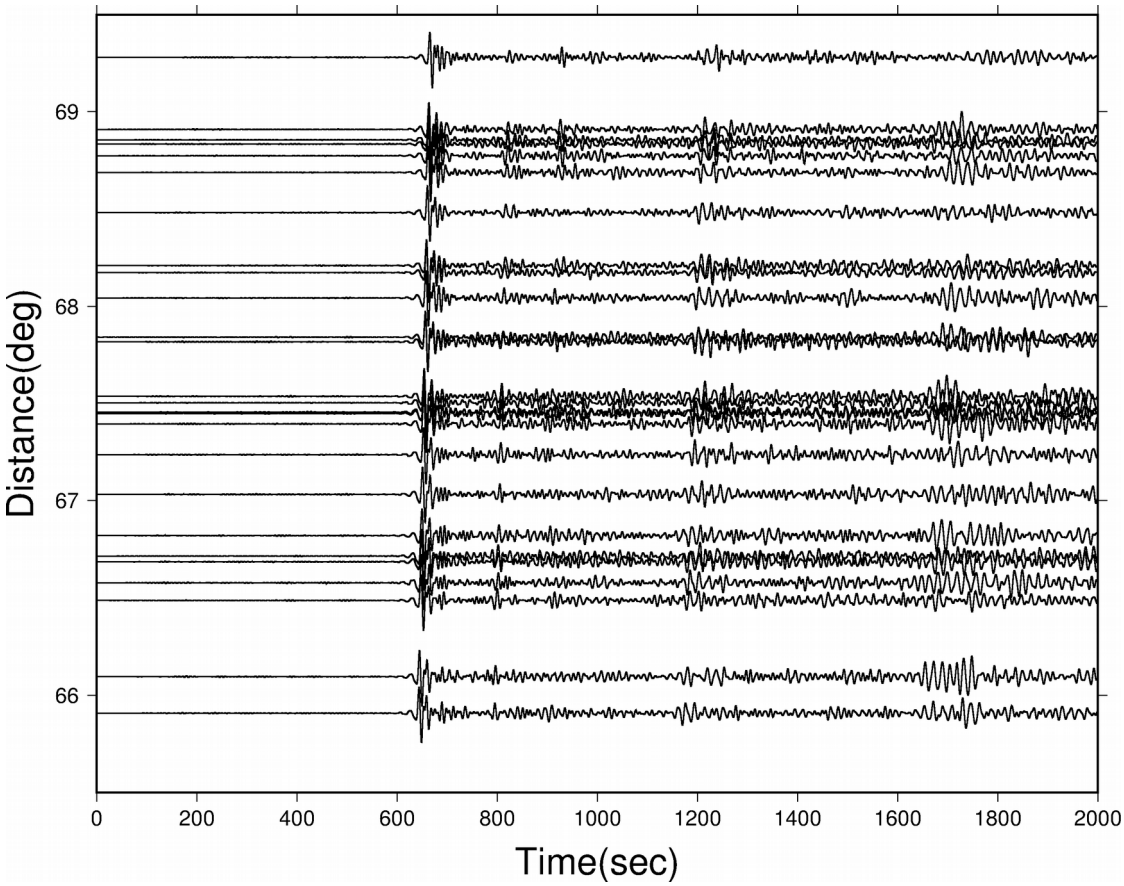


Actually, the epicenter of this event locates in the place which is near coast of Guatemala, 13.7527°N, -90.9488°W, and the seismic array used in this example is installed in Alaska,US. The great circle arc is about 67.62°, back-azimuth 103.563°, and referenced depth of hypocenter is 46.82 km. We calculate synthetic values, here, travel times , Ray Parameters and corresponding seismic phase names using Taup solftware (by USC) shown as blow,

Model: iasp91

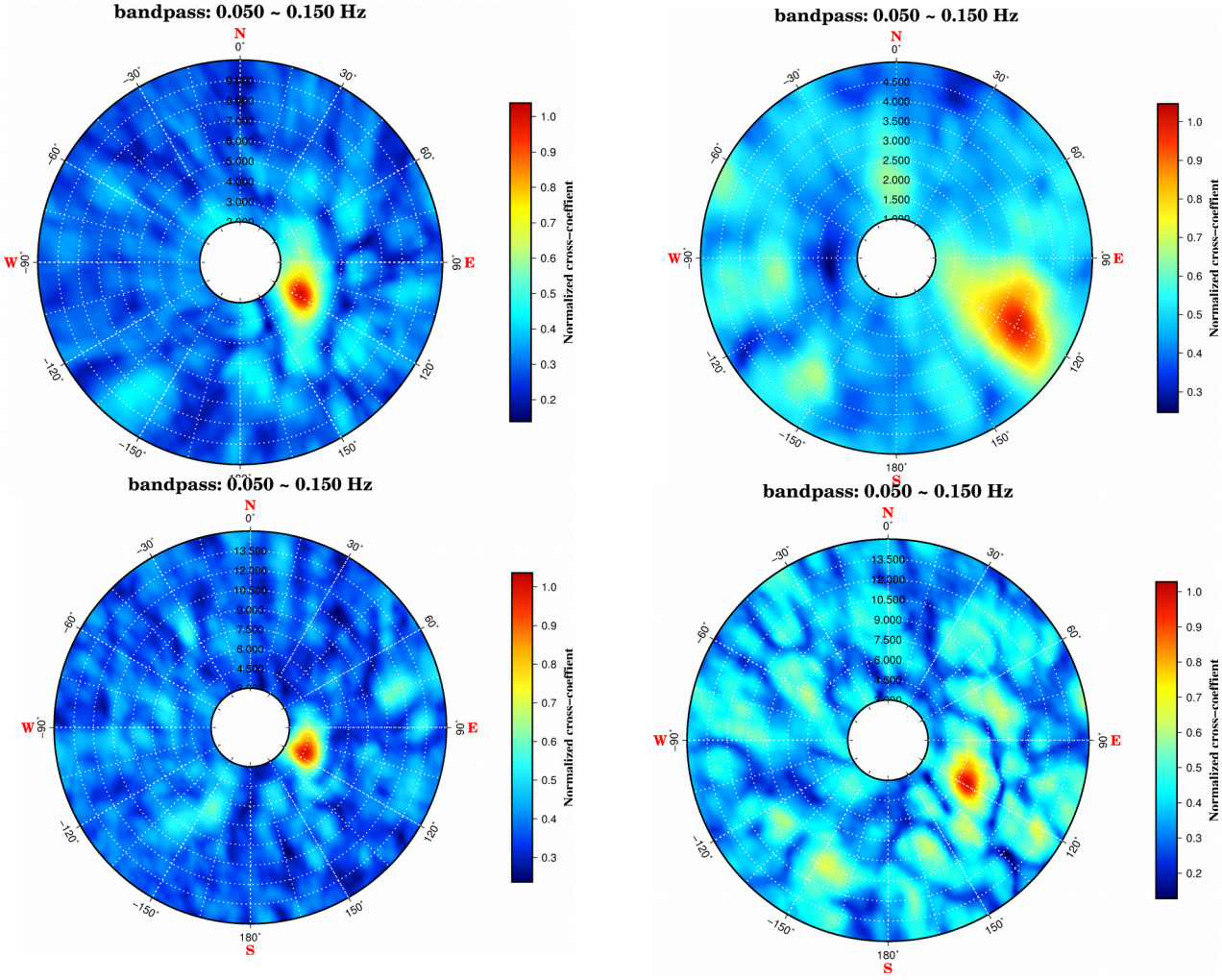
Distance (deg)	Depth (km)	Phase Name	Travel Time (s)	Ray Param p (s/deg)	Takeoff (deg)	Incident (deg)	Purist Distance	Purist Name
67.62	46.8	P	651.87	6.311	27.37	19.22	67.62	= P
67.62	46.8	pP	665.27	6.336	152.51	19.30	67.62	= pP
67.62	46.8	PcP	678.42	4.184	17.75	12.61	67.62	= PcP
67.62	46.8	pPcP	692.43	4.180	162.27	12.59	67.62	= pPcP
67.62	46.8	PKiKP	1035.95	1.365	5.71	4.08	67.62	= PKiKP
67.62	46.8	sS	1209.01	12.022	150.84	21.30	67.62	= sS
67.62	46.8	ScS	1246.07	7.795	18.42	13.62	67.62	= ScS
67.62	46.8	PKiKS	1250.47	1.421	5.94	2.46	67.62	= PKiKS
67.62	46.8	sScS	1270.37	7.786	161.60	13.61	67.62	= sScS
67.62	46.8	SKiKS	1459.81	1.480	3.44	2.56	67.62	= SKiKS
67.62	46.8	sSKiKS	1484.97	1.480	176.56	2.56	67.62	= sSKiKS

These raw seimsic data (actually, filtered with 0.05 ~ 0.15 Hz)of this array are plotted as the following figure shows,



2.1 Get proper back-azimuth and rough slowness with Beam forming method

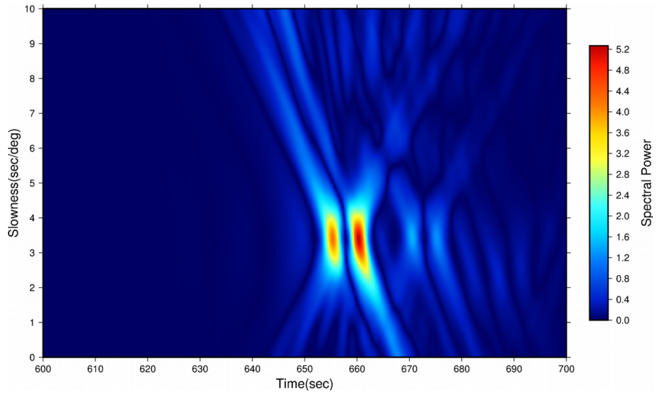
Here we first find the back-azimuth and rough slowness using Beam forming method, to know more matials and see "***ARRAY SEISMOLOGY: METHODS AND APPLICATIONS***" by *Sebastian Rost* and *Christine Thomas, 2004, Reviews of Geophysics.* *Result is shown by following figure,*

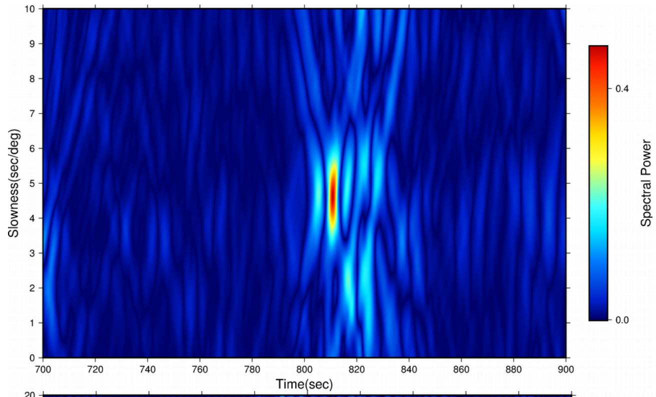


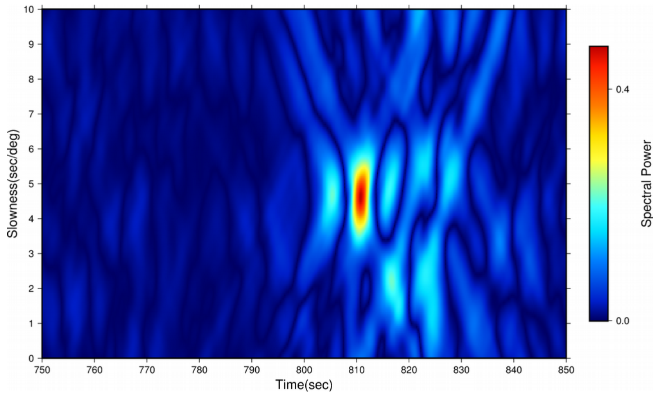
As the result of executing beam forming revealed(time windows are 600~700s, 700~800s, 700~1000s and 1150~1250s, respectively, the proper back-azimuth is 118°.

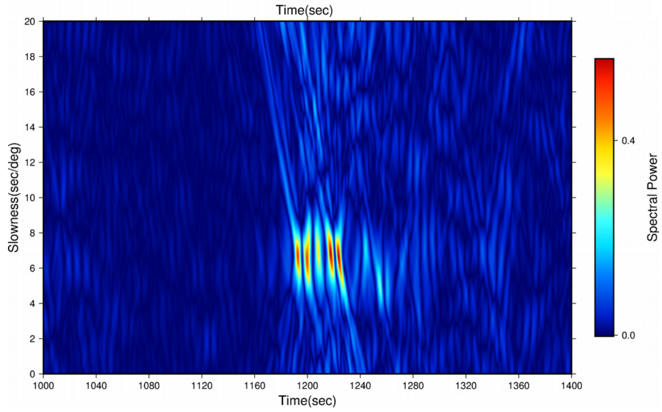
2.2 Fix back-azimuth 118° and scan slowness

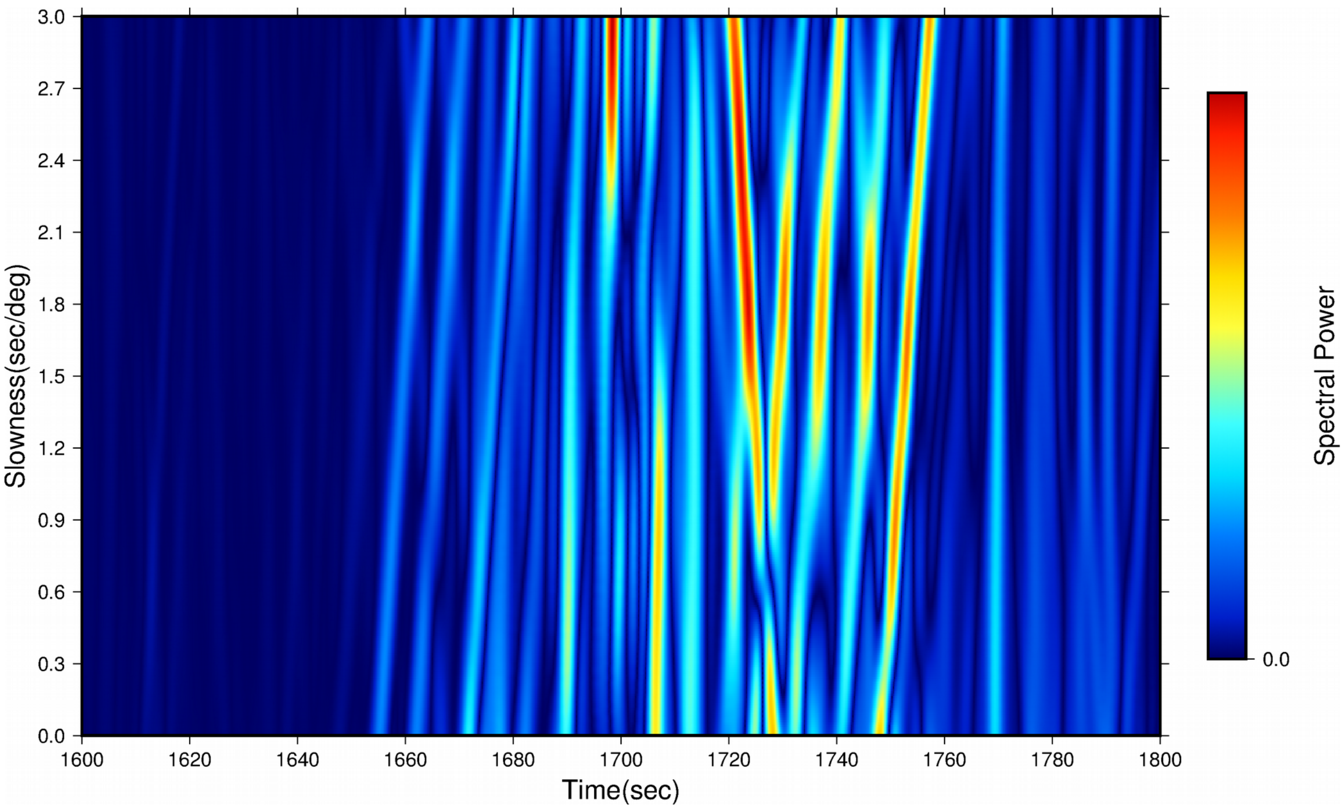
Now we scan the slowness with fixed back-azimuth 118° and see firgures blow,











2.3 Fix slowness and scan back-azimuth

Now we scan back-azimuth with fixed slowness, see results below,