Description of dataset “Data of shallow seismic profiles in the Alai valley, Kyrgyzstan, collected within the CaTeNA project”

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Abstract
The dataset contains waveform data of shallow seismic profiles at two locations in the western part of the Alai valley, Kyrgyzstan. At each location a “long” profile (~5 km and ~2.5 km length, respectively) and one or two short profiles (~120 m and ~250 m) were acquired, centered on known or presumed tectonic faults. As sources, a trailer-mounted weight drop and a hammer were used. The measurements were part of the CaTeNA project.

Coordinates: 39.41N°,72.39°E
Keywords: Shallow seismic profiling, reflection, refraction, thrust fault, Pamir, Tien Shan, fault zone structure, compressional waves, shear waves

1. Introduction

Within the sub-project "The recent deformation in the Pamir based on seismic and geodetic data, dynamic landslide-susceptibility and risk analysis, and seismic imaging of the North Pamir Thrust", which forms part of the international and interdisciplinary CaTeNA project (Climatic and Tectonic Natural Hazards in Central Asia), shallow seismic profiling at two locations has been carried out in the Alai Valley, southern Kyrgyzstan (see Figure 1), to investigate the spatio-temporal evolution of the Pamir Frontal Thrust (PFT).

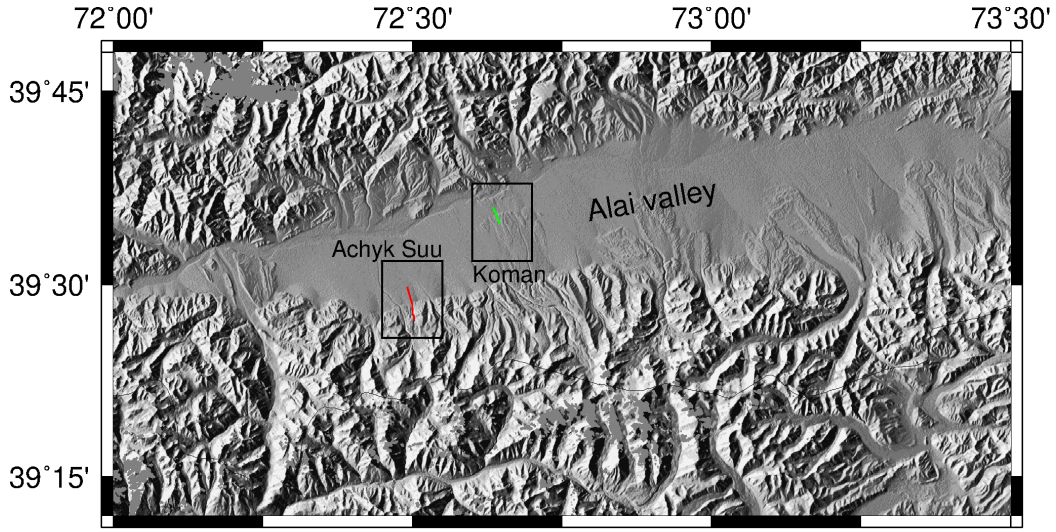

Figure 1: Overview map of the study areas (in village of Achyk Suu and at Koman fault) in the Alai valley, southern Kyrgyzstan. Shading indicates topography.

2. Data Acquisition – Experiment, schedule, acquisition parameters

The seismic profiles (Table 1) were acquired in September 2019 at two locations in the western part of the Alai valley, 1) in the village of Achyk Suu and b) at the Koman fault (SSW of the village of Kashka Suu). At each location a long profile (5 and 2.5km, respectively) and one or two short profiles (~250m) across interesting (presumed) fault structures were acquired (see Figures 1 and 2).

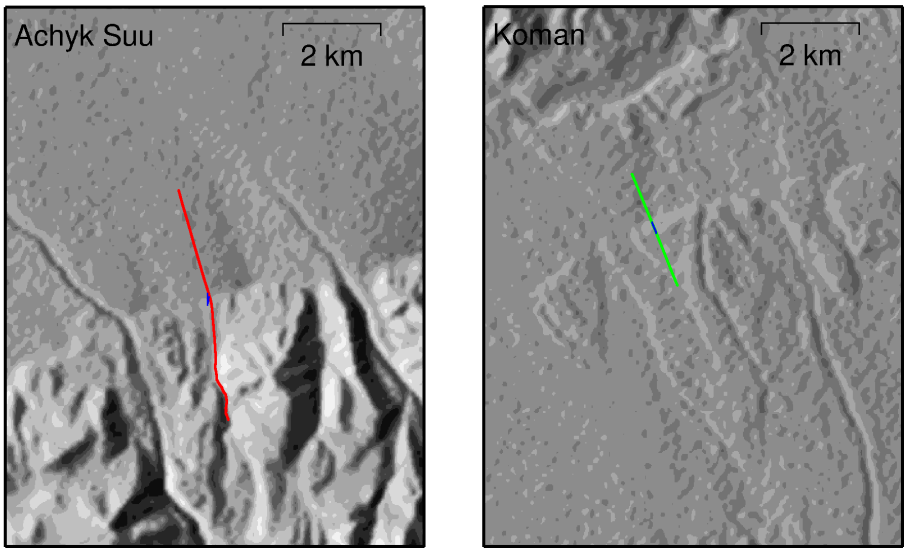

Figure 1: Close-up's of the study areas in Achyk Suu (left) and at the Koman fault (right). See Figure 1 for location. Colored lines indicate the seismic profiles (the position of the short profiles (blue) in the centre of the long profiles is barely visible at this scale). Shading indicates topography.

Table 1:

#	Profile-name (segy file name)	Length (m)	Source type	Number of source points	Source spacing (m)	Acquisition system	Number of receiver points	Number of active channels	Receiver spacing (m)	Samples per second
1	Achyk_Suu_long (as_long.segy)	4850	Weight drop	195	25	Omnirecs/ DIGOS Cube	970	300	5	400
2	Achyk_Suu_short_P (as_short_p.segy)	240	Hammer (vertical)	79	4[1]	Geometrics GEODE 24	240	120	1	4000
3	Achyk_Suu_short_S (as_short_s.segy)	240	Hammer (horizontal)	85	4[1]	Geometrics GEODE 24	240	120	1	4000
4	Achyk_Suu_small_P (as_small_p.segy)	120	Hammer (vertical)	41	3	Geometrics GEODE 24	120	120	1	4000
5	Achyk_Suu_small_S (as_small_s.segy)	120	Hammer (horizontal)	41	3	Geometrics GEODE 24	120	120	1	4000
6	Koman_long (ko_long.segy)	2425	Weight drop	98	25	Omnirecs/ DIGOS Cube	485	300	5	400
7	Koman_short_P (ko_short_p.segy)	240	Hammer (vertical)	61	4	Geometrics GEODE 24	240	120	1	4000
8	Koman_short_S (ko_short_s.segy)	240	Hammer (horizontal)	61	4	Geometrics GEODE 24	240	120	1	4000

Weight drop was a Omnirecs/DIGOS SSD-6600 trailer-mounted seismic weight drop. For the “short” and “small” profiles a ~6 kg sledge hammer was used, which was hit vertically on a base plate (P-waves) or horizontally on an “anvil” (Haines, 2007) for SH-signals, respectively. For the “long” profiles, 4.5 Hz vertical geophones were used, for the “short” and “small” profiles 10 Hz vertical and 10 Hz (ca. 80%) and 4.5 Hz (20%) horizontal geophones (not documented), respectively. Horizontal geophones were oriented perpendicular to the profiles (SH mode). Timing of the cube recorders was provided by built-in GPS (cycled mode). Origin times of weight-drop sources were taken by trigger-cubes with GPS time base and using a hammer switch mounted at the base plate. The GEODE recordings were triggered by the hammer blow (with trigger switch at hammer). At each source location we realized 5 (P-signals) sources which were later (vertically) stacked in order to improve the S/N ratio. For the SH-recordings we realized 3 hammer shots at

1 For first part of the profile source spacing 2m

each source location in each of the two opposite polarization directions (perpendicular to the profile) which were later subtracted in order to enhance the SH signals and to suppress the P signals.
All “long” and “short” profiles were acquired in a “roll-along” mode, with an active spread of 300 channels (~1500 m; “long” profiles) or 120 channels (~240 m and ~120 m; “short” and “small” profiles), respectively. The “Achyk Suu small” profile was fixed spread. Coordinates of all receivers and sources of the long profiles were measured with a differential GPS device, therefore the accuracy of the coordinates is in the order of 1 m. For the short profiles a tape measure was used (together with accurate coordinates of the end-points by differential GPS) thus resulting in a relative accuracy of ~1 dm (and absolute accuracy of ~1 m).

3. Data Processing

Raw cube data were converted to SEG-Y format (Berry et al., 1975) using the *GIPPtools* program collection (Lendl, 2021). This converted data and the original SEG-Y data of the GEODE seismic acquisition system was imported into the ProMAX/SeisSpace program package (Landmark) with which it was further processed (geometry installation, vertical stacking, subtracting of corresponding SH hammer shots with opposite direction in case of SH signals, manual/visual false polarity reversal) and exported (to SEG-Y files, see below). No other (pre-)processing has been applied to this data set.

4. Data Description

The dataset contains raw data in proprietary cube format and SEG-Y format (Berry et al. (1975); original GEODE recordings and files exported from ProMAX/SeisSpace).
The data is ordered in the directory structure listed in Table 2. The header words of the SEG-Y files are described in Table 3. All coordinates, shot and receiver lists are in plain ASCII format in directory /INFO including a README-file (see also Appendix 1).

Table 2: Directory and file structure

Directory	Files; content	Sub-directories	Content of sub-directories
/RAW	Raw data	/CUBE_raw/data/cube-??? (??? are cube S/N numbers between 001 and 999) /GEODE_raw/??.sgy and /GEODE_raw/???.sgy	Original cube data in subsequent directory structure Original Geode data in files *.sgy
/SEGY	Converted and pre-processed SEG-Y data (exported from ProMax/SeisSpace)	/[segy-file-name of Table 1]	Final pre-processed data (see section 4)
/INFO	Geometry files (coordinates, shot times, recorder-IDs, etc.) and further information for each profile & README file (see Appendix 1)	-	-

Table 3: SEGY-header words set

SU header word[2]	SEGY header byte	Length (byte)	Description[3]	Value, if constant
tracl	0	4	Trace number within this file	
tracr	4	4	Trace number within this file	
fldr	8	4	field record number = shot point number	
tracf	12	4	receiver channel number	
ep	17	4	shot point number	
cdp	21	4	Cdp number	
cdpt	25	4	surface location number	
trid	28	2	trace identification code	

2 SU == CWP/SU Seismic Un*x (Cohen & Stockwell, 2010)
3 Decription can be different to original sukeyword definition!

nhs	33	2	Number of vertically stacked traces	
offset	36	4	Distance from source to receiver	
gelev	40	4	Receiver elevation (m)	
selev	44	4	Source elevation (m)	
scalel	68	2	scale factor for bytes 40-67	-10000[4]
scalco	70	2	scale factor for bytes 72-87	-100[4]
sx	72	4	Source coordinate - X	
sy	76	4	Source coordinate - Y	
gx	80	4	Receiver coordinate - X	
gy	84	4	Receiver coordinate - Y	
counit	88	2	Coordinate units for bytes 72-84	3[5]
ns	114	2	number of samples in trace	4000 (long) 6800 (short)
dt	116	2	sample interval; in micro-seconds	2500 (long) 250 (short)
year	156	2	year data recorded (shot time)	
day	158	2	day of year	
hour	160	2	hour of day	
minute	162	2	minute of hour	
sec	164	2	second of minute	

6. Data Availability/Access

Data is archived at the *GIPP Experiment and Data Archive* where it is freely available for further use after the end of the embargo period on October 31, 2023. When using the data, please give reference to this data publication. Recommended citation is:

> **T. Ryberg, C. Haberland, U. Abdybachaev, & A. Sharshebaev** (2021) Data of shallow seismic profiles in the Alai valley, Kyrgyzstan, collected within the CaTeNA project. GFZ Data Services. Doi: 10.5880/GIPP.201914.1

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References

Cohen, J. K. and Stockwell, Jr. J. W., (2010), CWP/SU: Seismic Un*x Release No. 4.2: an open source software package for seismic research and processing, Center for Wave Phenomena, Colorado School of Mines.

Barry, K.M.; Cavers, D.A.; Kneale, C.W. (1975): *Recommended standards for digital tape formats*. Geophysics 40 (2), pp. 344–352, doi: 10.1190/1.1440530.

Haines, S.S. (2007) A Hammer-impact, aluminum, shear-wave seismic source, U.S. Geological Survey Open-File Report 2007-1406, 5 p., available only online at http://pubs.usgs.gov/of/2007/1406/.

Lendl, C. (2020). GIPPtools (Version 2020.352). Zenodo. http://doi.org/10.5281/zenodo. 4707612

4 If negative, number is divisor

5 All coordinates are given in UTM (multiplied by scalco)

Appendix 1:

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This is a short description of the additionally provided information
(e.g. tables with coordinates of shot and receivers etc. in ASCII format;
"geometry").

*Long profiles* (at Achyk Suu and Koman, Cube acquisition)

File type of files achyk_suu_long.spread? and koman_long.spread?

Can be used to build the shot data from original cube data using e.g. the
       GIPPtools

One file for each spread of the roll-along measurement of each long profile
with receiver and shot coordinates, cube-numbers etc.

Example achyk_suu_long.spread1 contains
R rp001 72.5032215300 39.4535653200 3120.24 1 c0070 p0 2019-08-19 2019-08-26
R rp002 72.5032027600 39.4536078600 3120.06 2 c0780 p0 2019-08-19 2019-08-26
R rp003 72.5031837800 39.4536505000 3119.86 3 c0707 p0 2019-08-19 2019-08-26
R rp004 72.5031646300 39.4536931800 3119.64 4 c0934 p0 2019-08-19 2019-08-26
...
R RP#    lon           lat         elevation RP# cube_number

S s0101 72.503222 39.453565 3120.244000   101 2019-08-20T09:14:36.2503819
S s0102 72.503222 39.453565 3120.244000   102 2019-08-20T09:15:25.3901736
S s0103 72.503222 39.453565 3120.244000   103 2019-08-20T09:15:59.5153125
S s0104 72.503222 39.453565 3120.244000   104 2019-08-20T09:16:40.8389931
S s0105 72.503222 39.453565 3120.244000   105 2019-08-20T09:17:16.3484722
S s0601 72.503126 39.453779 3119.189000   601 2019-08-20T09:22:11.8761111
S s0602 72.503126 39.453779 3119.189000   602 2019-08-20T09:22:47.8660070
...
S sub_shot lon      lat      elevation   sub_shot# time_UTC

sub_shots are generated from the shot location number multiplied by 100 and
       added the shot# (to be vertically stacked)

Same for other spreads along the two long profiles

Example achyk_suu_long_rp.dat
1  72.50322153  39.45356532 3120.244     1     070  285173.450  4370086.613 43
2  72.50320276  39.45360786 3120.058     2     780  285171.966  4370091.380 43
3  72.50318378  39.45365050 3119.855     3     707  285170.464  4370096.158 43
4  72.50316463  39.45369318 3119.644     4     934  285168.947  4370100.941 43
5  72.50314537  39.45373585 3119.433     5     932  285167.421  4370105.724 43
6  72.50312567  39.45377868 3119.189     6     669  285165.857  4370110.525 43
…
RP# lon         lat         elev (m)    RP#    cube_number UTM_X UTM_Y UTM_zone

Same for Koman long profiles

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*Short and small profiles* (at Achyk Suu and Koman, GEODE acquisition)

Example achyk_suu_short_rp.dat (station & source locations)
  1 72.498299 39.474857 2980.439000   1   0 284815.488000 4372461.704000 43
  2 72.498299 39.474866 2980.259000   2   0 284815.514000 4372462.713000 43
  3 72.498299 39.474875 2980.111000   3   0 284815.541000 4372463.697000 43
  4 72.498299 39.474883 2979.995000   4   0 284815.568000 4372464.629000 43
```

...
location long lat elevation location 0 UTM coordinates

Example achyk_suu_short_v_ffid_sp.dat (vertical source)
14 1
15 3
16 5
17 7
...
FFID (in GEODE segy file) shot location

Same for achyk_suu_short_h1_ffid_sp.dat (1st horizontal source component)
Same for achyk_suu_short_h2_ffid_sp.dat (2nd horizontal source component)

Same for Achyk Suu small profile, Koman long & Koman short

List of files:
achyk_suu_long_rp.dat
achyk_suu_long.spread1
achyk_suu_long.spread2
achyk_suu_long.spread3
achyk_suu_long.spread4
achyk_suu_long.spread5
achyk_suu_long.spread6
achyk_suu_long.spread7
achyk_suu_long.spread8
achyk_suu_short_h1_ffid_sp.dat
achyk_suu_short_h2_ffid_sp.dat
achyk_suu_short_rp.dat
achyk_suu_short_v_ffid_sp.dat
achyk_suu_small_h1_ffid_sp.dat
achyk_suu_small_h2_ffid_sp.dat
achyk_suu_small_rp.dat
achyk_suu_small_v_ffid_sp.dat
koman_long_rp.dat
koman_long.spread1
koman_long.spread2
koman_long.spread3
koman_short_h1_ffid_sp.dat
koman_short_h2_ffid_sp.dat
koman_short_rp.dat
koman_short_v_ffid_sp.dat
README