

Long Term Axial Strain Monitoring

High Pressure Natural Gas Pipeline

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Where do we monitor pipelines

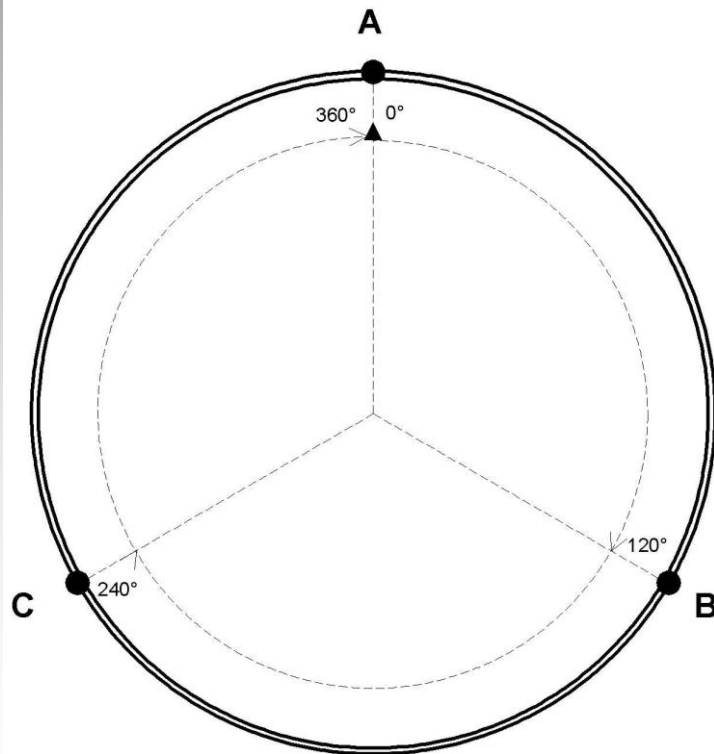
- Landslide areas
- Black coal undermined areas (settlement)

How do we measure axial strain

- 3 spot weldable strain gages in a profile
 - Manual measurement with readout box
 - Automatic measurement with datalogger
-
- Pipeline diameters are from 200 to 500mm

Position of the sensors

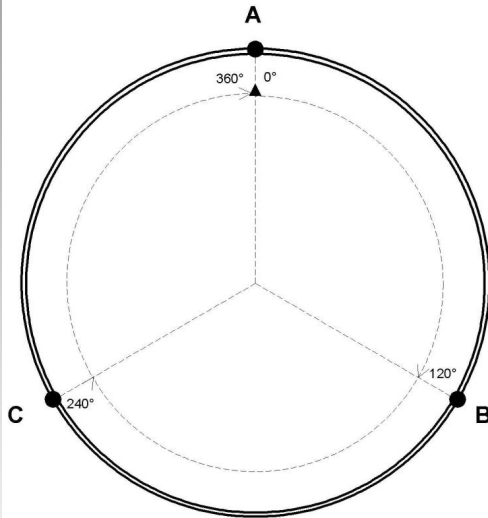
Umístění snímačů v kontrolním profilu
a způsob označení při pohledu ve směru staničení



- 3 strain gages in each profile - every 120°
- distribution of the strain around circle profile forms a sine curve
- calculation of maximum, minimum and their position on the circle

Sine curve theory

Umístění snímačů v kontrolním profilu
a způsob označení při pohledu ve směru staničení



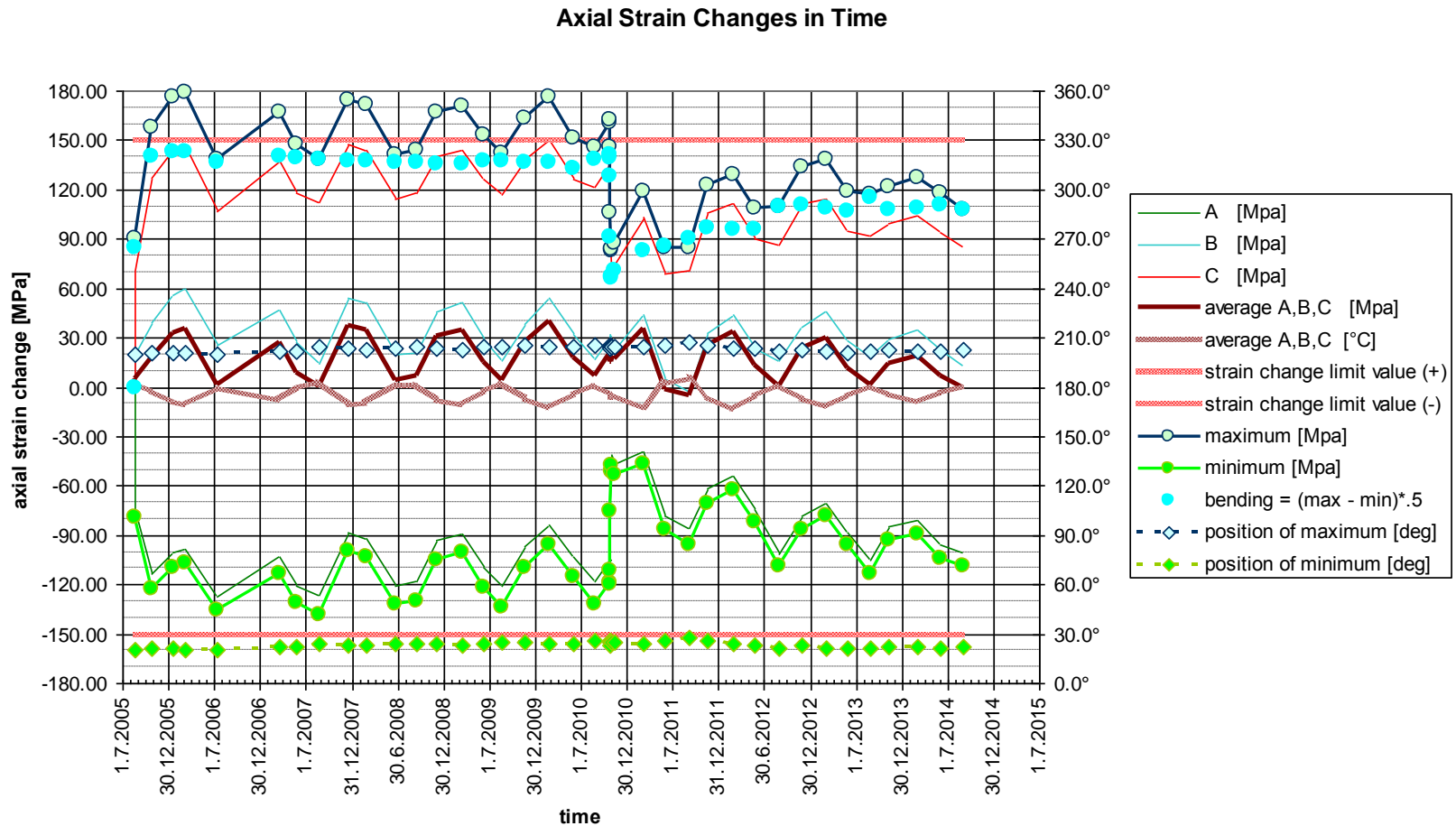
- $y_1 = a * \sin(x_1 + b) + c$
- $y_2 = a * \sin(x_2 + b) + c$
- $y_3 = a * \sin(x_3 + b) + c$
- where
- $y_1, y_2, y_3 \dots$ reading at A, B, C [MPa]
- $x_1, x_2, x_3 \dots$ A, B, C position [rad]
- $a \dots$ multiply constant - pipeline bending
- $b \dots$ deflection of bending plane
- $c \dots$ average strain without bending

Manual readings

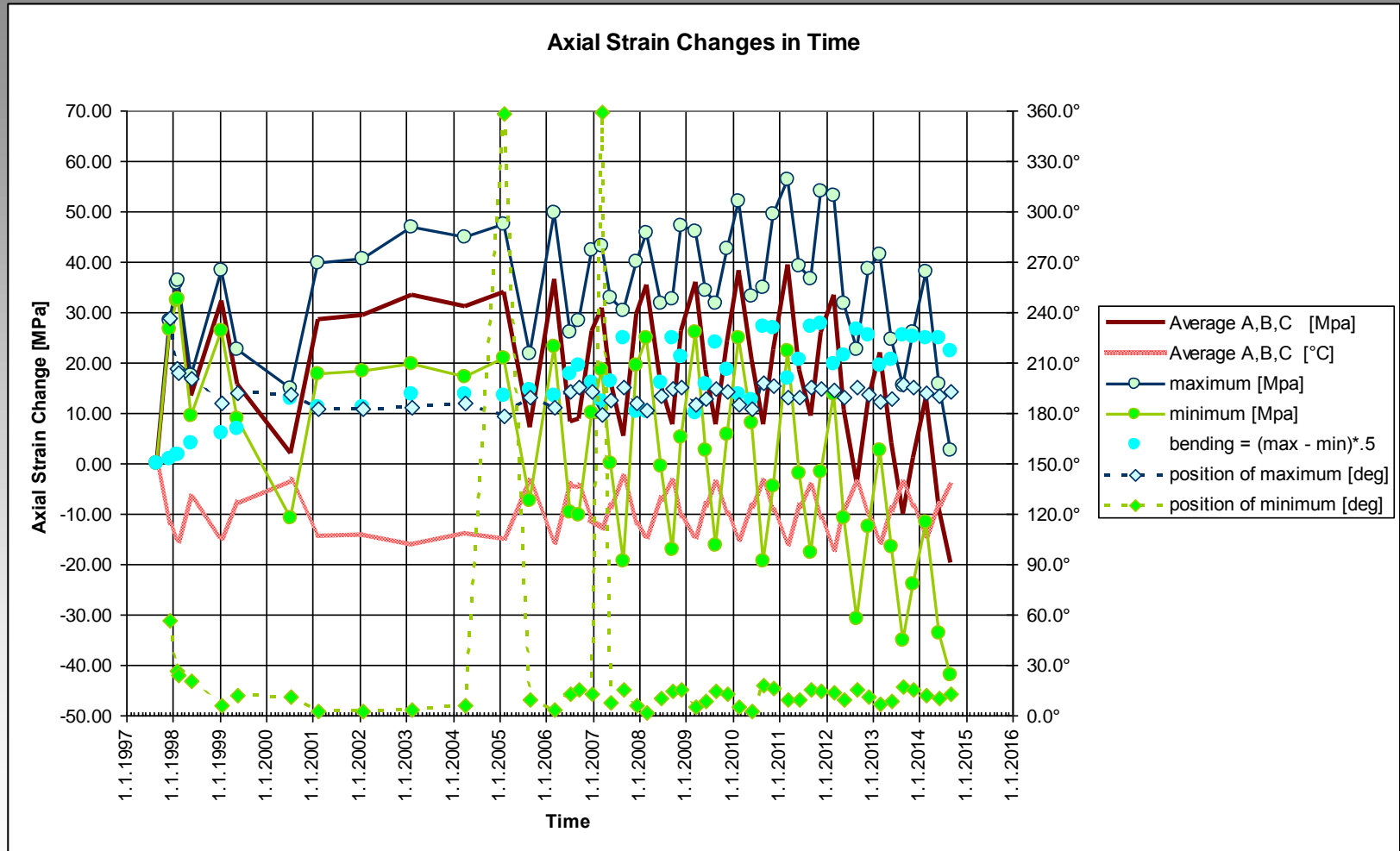


- We started in 1995
- Mostly undermined areas
- Till now:
 - 173 profiles
 - 519 strain gages
- They are measured 4 times a year (only the newest once a month)

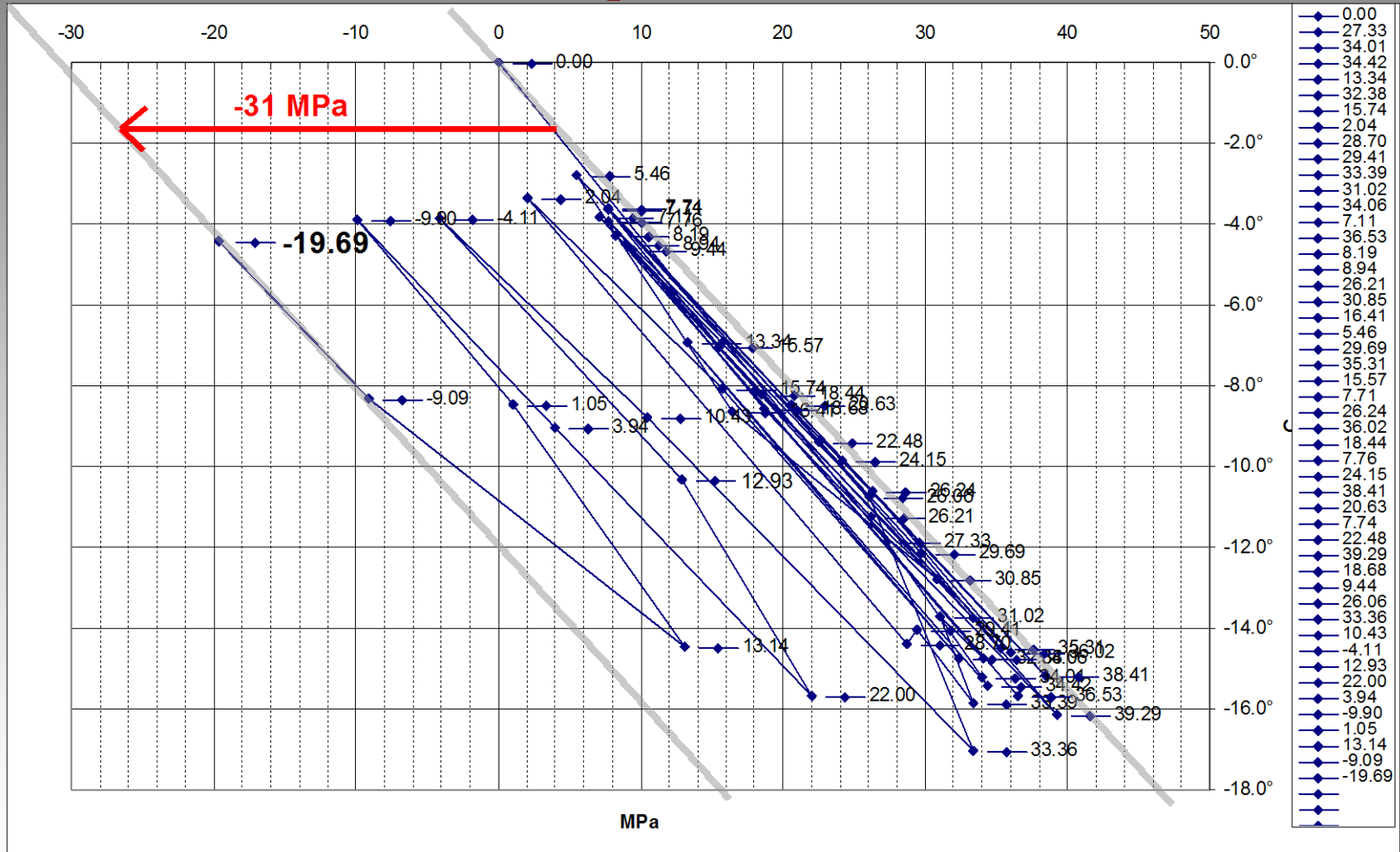
Manual readings graph



Manual readings graph



Relation between strain and temperature



Automatic readings



Pipeline construction



Automatic readings history

- Started in year 2000 (249 strain gages, 11 CR10X, 22 MUXs, Siemens M20 modules)
- 2008: New profiles (111 strain gages, 4 CR800, 9 MUXs, Siemens TC35i modules)
- 2012: Dialed GSM connection changed to IP GPRS and Internet connection
- 2013: AVW1 changed to AVW200
- 2013: Server rental (cloud) with Windows 2008 Server, LoggerNet Admin and VDV

Vista Data Vision (VDV)

Vista Data Vision - Login x

109.123.193.3/vdv/index.html

Geomonitoring

Web access to Logged Data / Internetovy pristup k Vasim datum

Welcome to our Information Service / Vitejte v informacni sluzbe

User Name / Uzivatelske jmeno

Password / Heslo

Login / Vstupte

In order to connect to the service, please enter a User Name and Password / Prosim, zadajte uzivatelske jmeno a heslo a kliknete na Vstupte

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Start Microsoft PowerPoint ... Vista Data Vision - Lo... CS 18:28

VDV - Data visualization and their control

- Feeding databases with historical data
- Data update
- Battery supply
- Read data evaluation
 - rate of change
 - percentage of given limits
 - setting alarms (e-mails, SMS)
 - documentation data storage in the server

Battery supply and datalogger temperature since 2000



A profile graphs since 2008

Geomonitoring Main Functions Configuration Alarm Information

Sites

- 1AN1
- 2AN2
- 2AN3**
 - Profil 2AN3 Baterie a Teplota Dataloggeru
 - Profil 2AN3 1..3 Prehled
 - Profil 2AN3 1..3 Procenta Limitu
 - Profil 2AN3_01
 - Profil 2AN3_02**
 - Profil 2AN3_03
 - Profil 2AN3_01 Zmeny
 - Profil 2AN3_02 Zmeny
 - Profil 2AN3_03 Zmeny
 - Profil 2AN3 Zavislost ZAN na teplote
- 2AN4
- AN3 Zukov
- OMU01
- OMU04
- OMU05
- OMU06
- OMU09
- OMU10
- OMU11
- OMU23
- OMU78
- Sanec - Recica
- Teplota v kancelari

2AN3: Profil 2AN3_02

ZAN MPA 2AN3_02 (Automaticke meritko)

Plot	Latest
ZAN3_02A Mpa: 2AN3	-112.9
ZAN3_02B Mpa: 2AN3	83.08
ZAN3_02C Mpa: 2AN3	47.55
ZAN3_02 Prumer Mpa: 2AN3	5.905

ZAN MPA 2AN3_02 (+/-138 MPa)

Plot	Latest
ZAN3_02A Mpa: 2AN3	-112.9
ZAN3_02B Mpa: 2AN3	83.08
ZAN3_02C Mpa: 2AN3	47.55
ZAN3_02 Prumer Mpa: 2AN3	5.905

2AN3_02 Maximum Minimum

Plot	Latest
ZAN3_02A Mpa: 2AN3	-112.9
ZAN3_02B Mpa: 2AN3	83.08
ZAN3_02C Mpa: 2AN3	47.55
ZAN3_02 Prumer Mpa: 2AN3	5.905

2AN3_02 Maximum Minimum (+/-138)

Plot	Latest
ZAN3_02A Mpa: 2AN3	-112.9
ZAN3_02B Mpa: 2AN3	83.08
ZAN3_02C Mpa: 2AN3	47.55
ZAN3_02 Prumer Mpa: 2AN3	5.905

2AN3_02 Poloha Maxima a Minima

Plot	Latest
Poloha_MAX_02: 2AN3MM	170.2
Poloha_MIN_02: 2AN3MM	350.2

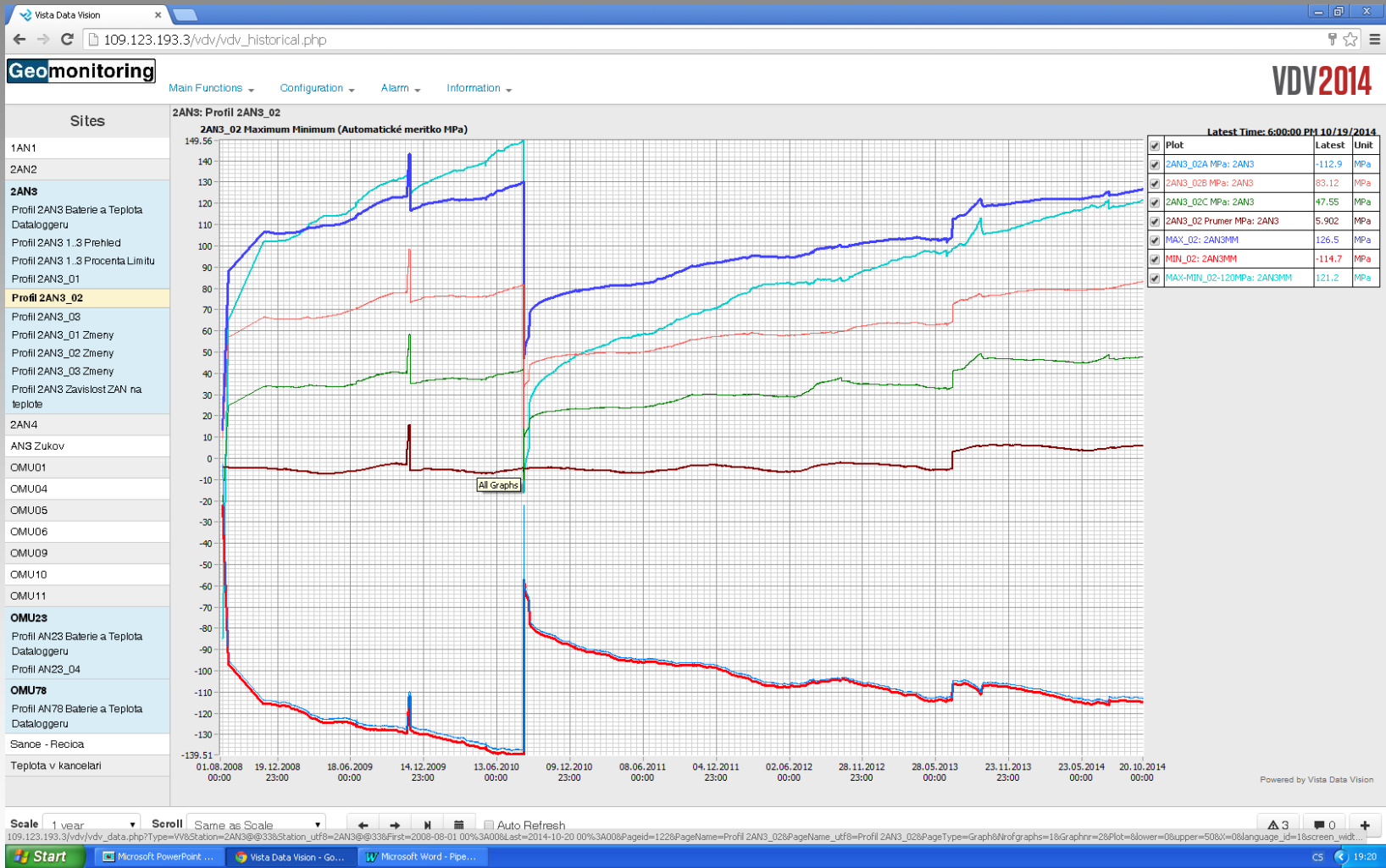
Teploty 2AN3_02

Plot	Latest
ZAN3_02_AT: 2AN3	12.42
ZAN3_02_BT: 2AN3	12.47
ZAN3_02_CT: 2AN3	12.20

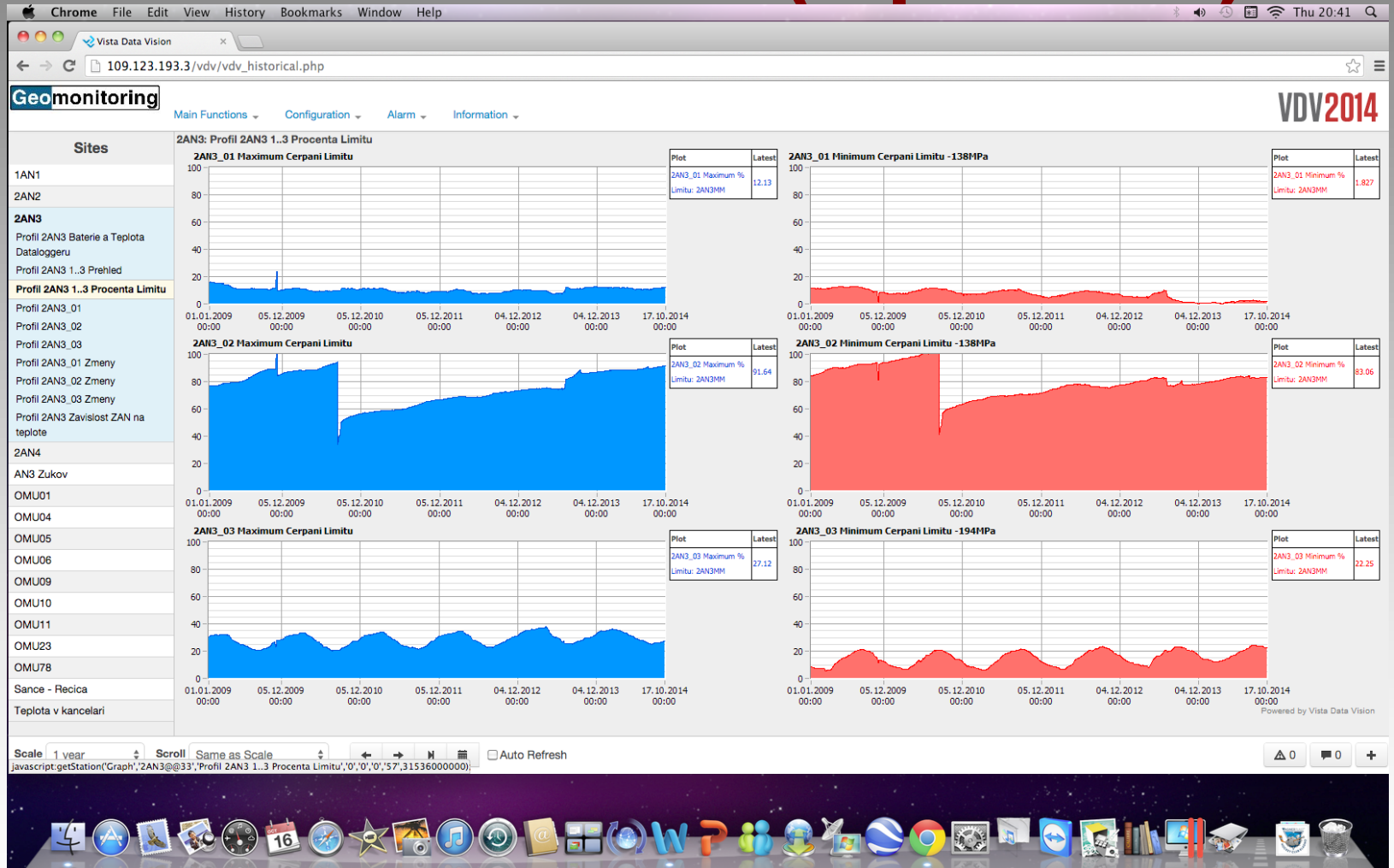
Scale: 1 year Scroll: Same as Scale Auto Refresh

Powered by Vista Data Vision

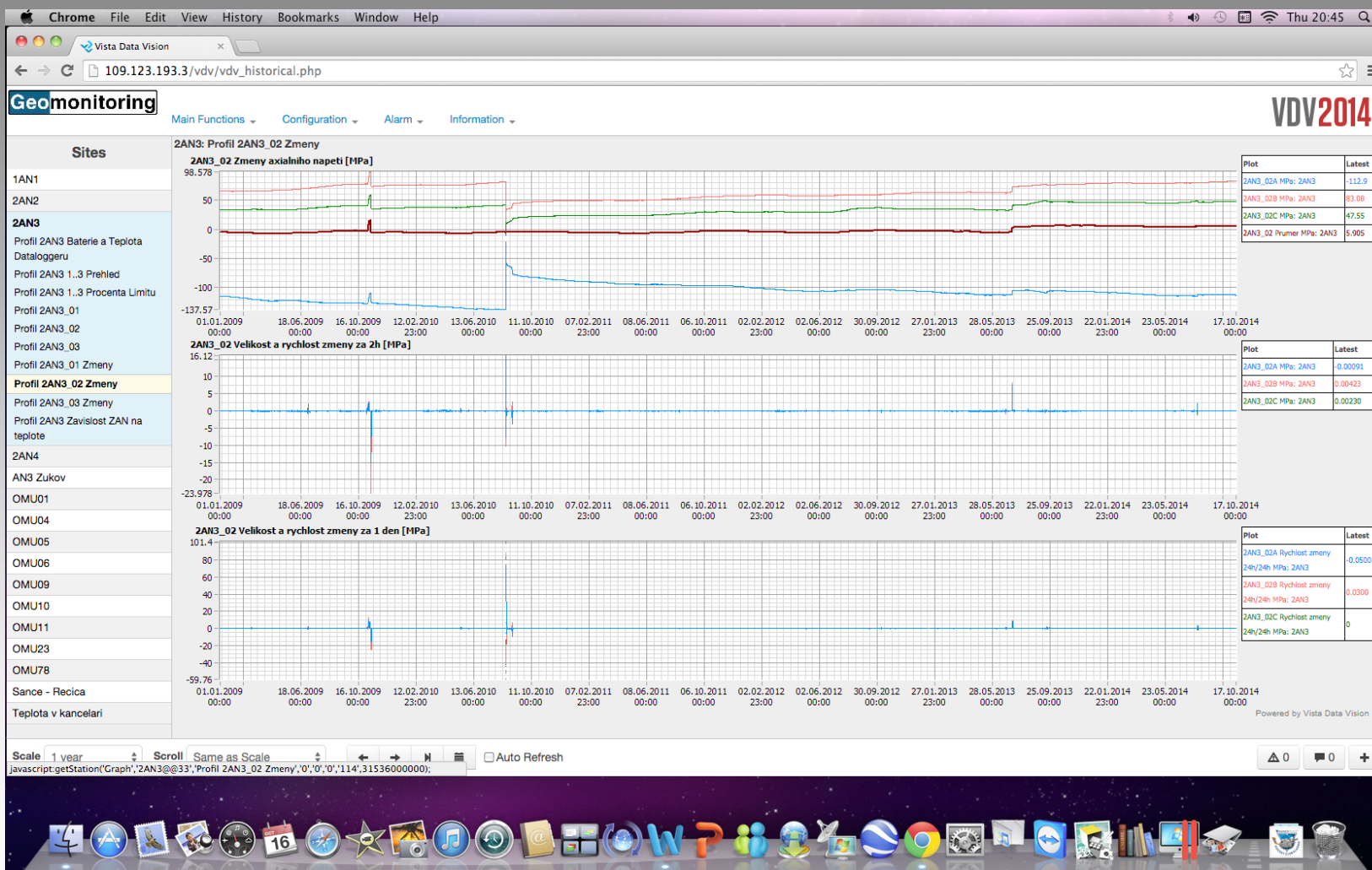
Maximum and minimums



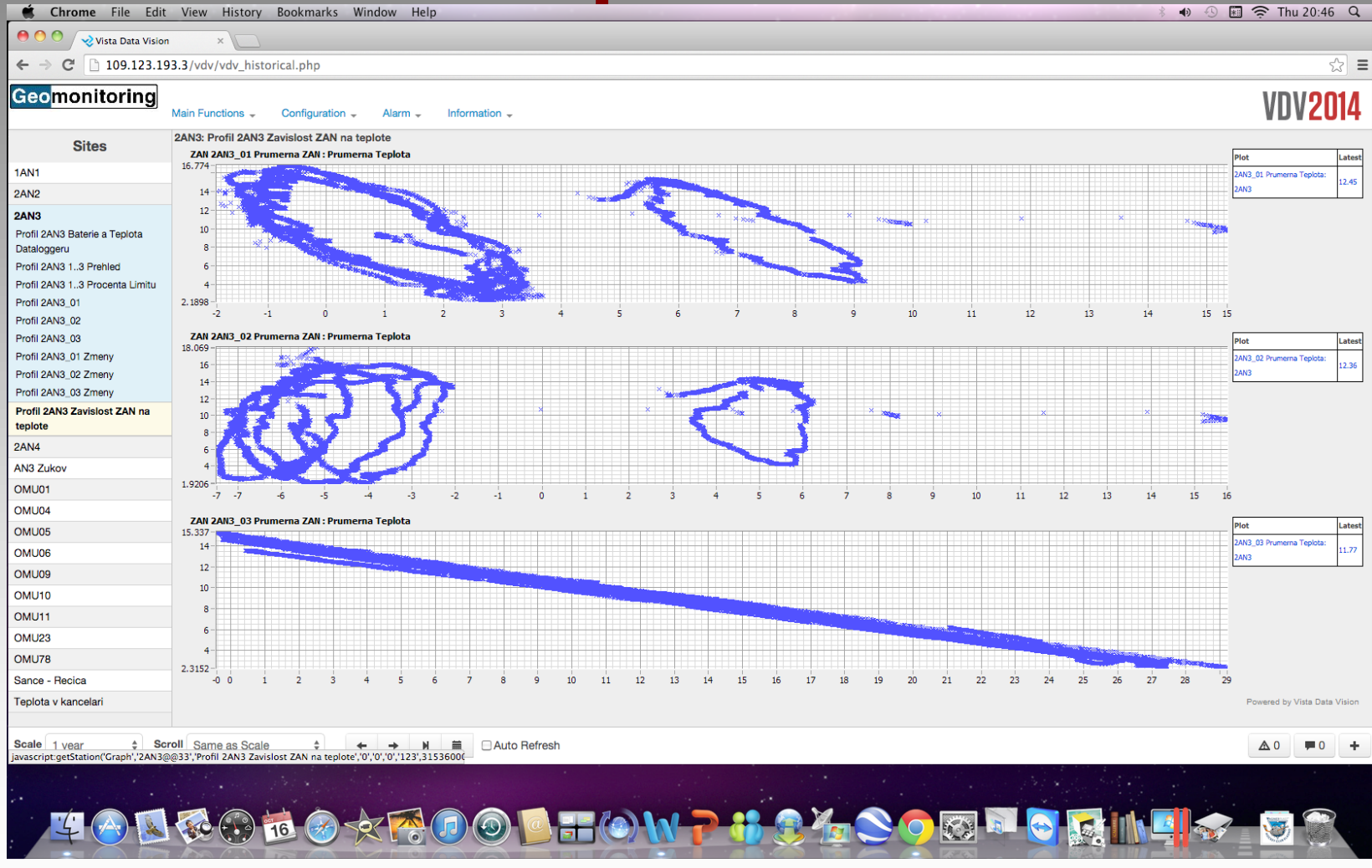
Percentage of maximum and minimum (3 profiles)



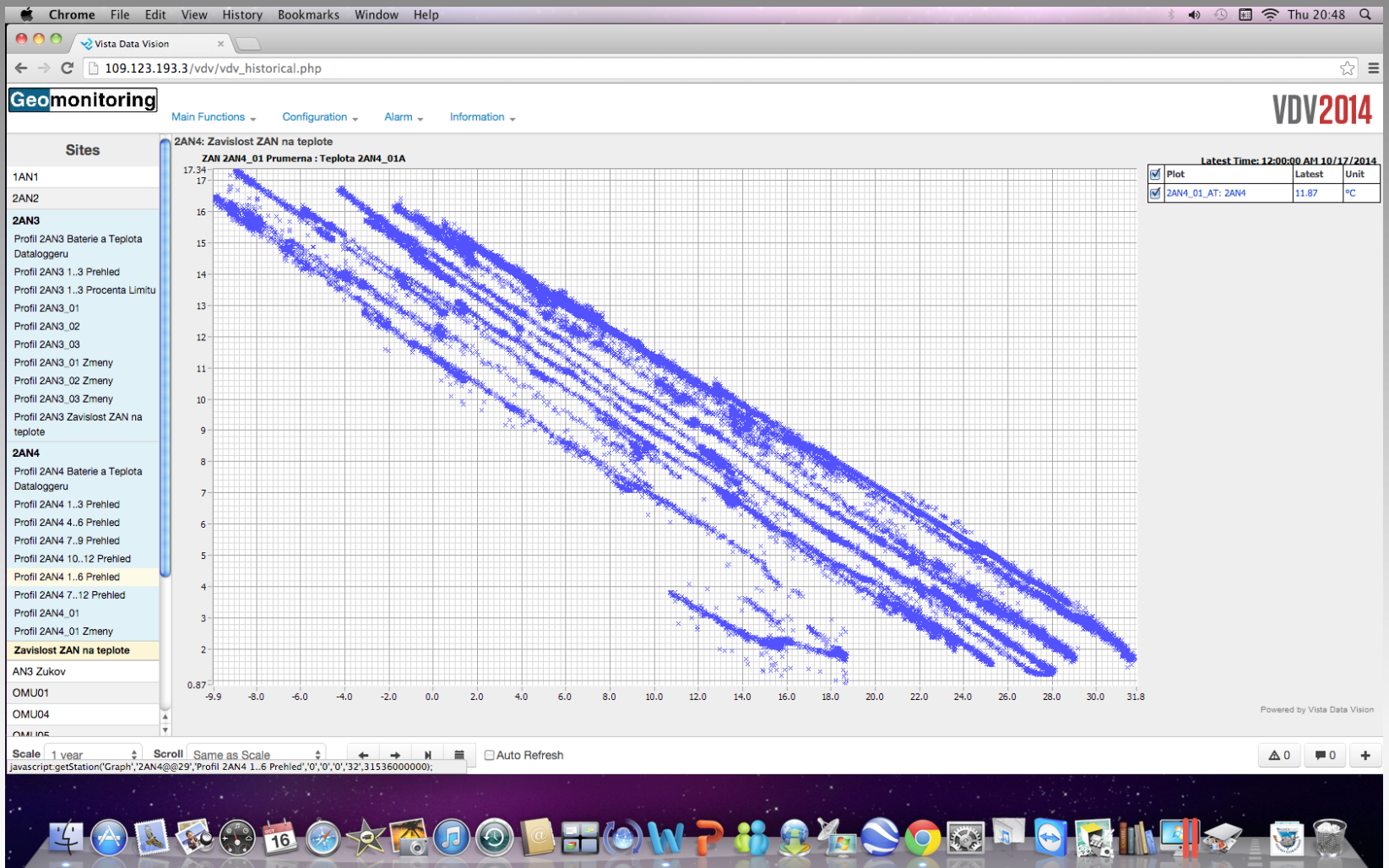
Rate of change



Relation between strain and temperature



A profile going to tension



Reading improvement after AVW200 installation (RoC)





Geomonitoring

Thank you...