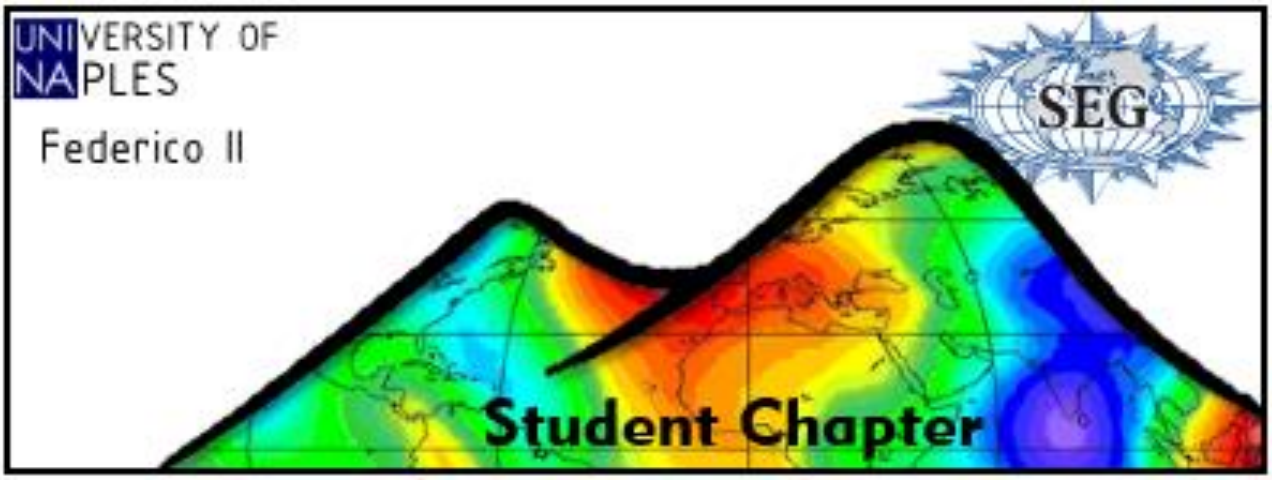


REPORT / LOG DIARY
EAGE Geophysics Boot Camp 2015
Week 1 (21-28 March 2015)
Emlichheim - Germania

LO RE Davide

27/04/15

UNIVERSITY OF NAPLES Federico II — SEG Student Chapter	REPORT / LOG DIARY EAGE Geophysics Boot Camp 2015 Week 1 (21-28 March 2015) Emlichheim - Germania	**LO RE** Davide	2015	27/04

EAGE Geophysics Boot Camp

The **goal** of the Geophysics Boot Camp is to provide students and young professionals with practical "hands-on" experience in carrying out different aspects of geophysical activities in an active oilfield. The participants will practice the use of different geophysical techniques including reflection and refraction seismic, gravity and ground-penetrating radar. Participants will be divided into teams in order to rotate between 'hands-on' tasks of survey installation, data acquisition and quality control, all with a variety of geophysical platforms and technologies. These geophysical observations will be consolidated into an integrated interpretation of the field.

The Geophysics Boot Camp **will enable participants to put theory into practice** and it is a great opportunity for those who have not yet been in the field, or wish to have the experience of geophysical data acquisition.

This is a great opportunity to meet peers from different companies and universities, Professors from acknowledged Universities and Industry Experts from different companies **to share knowledge and experience**, as well as benefit from networking.

I had the possibility to attend during the week 1 (21-28 March); below the schedule:

21 March	Travel to reach the accommodation site (Almelo, NL)
22 March	• Introduction and mandatory HSSE briefing • Geological day trip to Bad Bentheim
23 March	• Wintershall Facility visit (visit around operational facilities) • Deep Seismic Surveying (Seismic surveying by using Vibrotruck, including installation and recording equipment)
24 March	Shallow Seismic Surveying (Seismic surveying by using Non - Vibrotruck)
25 March	Deep Seismic Surveying (Seismic surveying by using Vibrotruck, including installation and recording equipment)
26 March	• Deep Seismic Surveying (Seismic surveying by using Vibrotruck, including installation and recording equipment) • Electrical/Electromagnetic Surveying (ERT and FDEM)
27 March	• Gravity Surveying (Measurement of local gravity field) • Ground Penetrating Radar (High - resolution imgaing of shallow subsurface structure)
28 March	Travel to come back.

GEOLOGICAL DAY TRIP TO BAD BENTHEIM (with TNO -Geological Survey of the Netherlands)

This field trip focuses on the Lower Cretaceous strata which form the oil play in the Lower Saxony Basin. The reservoir is formed by Lower Cretaceous Sandstones of the Vlieland Sandstone Formation. The seal is formed by Lower Cretaceous shales of the Vlieland Claystone Formation and finally the source rock is provided by the bituminous shales of the Coevorden Formation.

In the nineteenth and twentieth century the Bentheim area was known for its asphaltite mine at Sieringshoek. This asphalt mine actually triggered the hydrocarbon exploration in this area, once geologists realised the origin of the asphalt.

Additionally, Bentheim is well known for its building stone. The Bentheimer Sandstone has been mined for a long time. An enormous amount of building stones was exported to various countries including the Netherlands where landmark buildings such as the palace on the Dam Square in Amsterdam were built with Bentheimer Sandstone.

During the excursion (7 stop) was organized an **exercise**, to get a good look and feel of a the reservoir and structure of an oilfield in the subsurface. To achieve this, a number of outcrops (6) were visited in the Bentheim area. At these outcrops the surface geology was examined in terms of sedimentology, reservoir architecture and structural architecture, in particular:

- Types of lithology;
- Type and scale of sedimentological features;
- Presence of fossils and ichnofossils;
- Thickness and net-to-gross of the outcropping sandstone;
- Porosity of the sandstone;
- Dip and dip direction of the sandstone;
- Presence of joints, faults and other structural geologic phenomena.

They were formed 6 groups, to achieve six different solutions.

Just to make you known: ~~Nobody gave the correct answer~~.

Reference source:

EAGE Field Trip, The Bentheimer Sandstone-analgue for the Schoonebeek/Emlichheim Oil Reservoir, Harmen Mijnlieff and Geert-Jan Vis (TNO-Geological Survey of the Netherlands).

WINTERSHALL FACILITY VISIT (visit around operational facilities)

Obviously, no photo was permitted. (Confidentiality and Professional SECRECY)

A team of professional from Wintershall gave us the chance to see the main structure of the oil field with a lot of point of view (geological, economical, geophysical, security).

Wintershall's Emlichheim field is one of Germany's oldest crude oil production sites. An oil-bearing structure straddling the German-Dutch border was predicted in the late 1930's, although it was only in 1943 that the structure was proven to be hydrocarbon bearing on the German side. Indeed, the discovery well – Em 1 – which confirmed hydrocarbon prospectivity is still producing to this day, 70 years after start-up in 1944. Today, Wintershall operates a state-of-the-art EOR (enhanced oil recovery) facility which includes steam injection. By applying this technology, Wintershall expects to maintain a production rate of ~ 150,000 tons of oil per year from the Emlichheim field until at least 2015, and prolong production of the field until 2040 thereafter.

The main reservoir in the Emlichheim oilfield is the Bentheimer sandstone, an unconsolidated marine unit dating from approximately 135 million years ago in the Valanginian stage of the Lower Cretaceous. This reservoir is 700-900 m below mean sea-level.

Reference source:

Bootcamp Pre-Reading Materials 2015.

Deep Seismic Surveying (Seismic surveying by using Vibrotruck, including installation and recording equipment)

Seismic reflection methods are the principle tool with which the hydrocarbon industry maps and interprets the structure of potential hydrocarbon reservoirs. Although the discovery and characterization of an oilfield requires inputs from numerous data sources and geophysical techniques, it is seismic reflection methods which are at the heart of subsurface imaging in the petroleum sector.

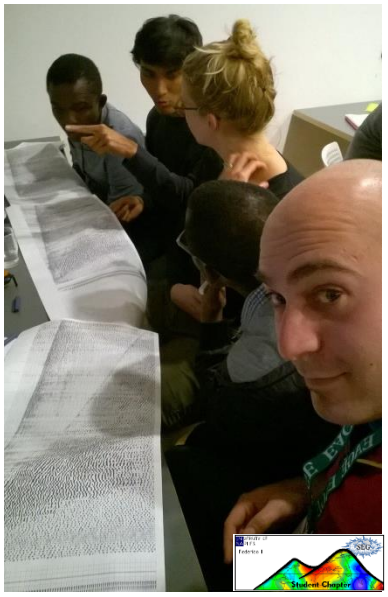
On the Boot Camp, we acquired a set of two-dimensional (2-D) seismic lines.

The source of seismic energy on the Boot Camp was an INOVA Univib vibrator truck, as provided by DMT GmbH & Co. KG. Being smaller than most industrial vibrators, it is ideally suited to operations in urban or restrictive natural environments. The unit weighs approximately 12 tons, and can generate a sweep of seismic energy with frequencies between 1-475 Hz.

The energy generated from the Univib was recorded using a Sercel 428/208 acquisition system, also provided by DMT. The system comprises 240 recording channels, which record the summed

output from a string of 12 geophones. The acquisition was coordinated from a recording unit (**Figure 4.4**), termed the doghouse in industry parlance.

After the acquisition, we met in a classroom to discuss about the quality of the data and to try to interpret the raw data.



Reference source:

Bootcamp Pre-Reading Materials 2015.

Shallow Seismic Surveying (Seismic surveying by using Non - Vibrotruck)

In a hydrocarbons context, seismic refraction methods provide valuable information for processing and correcting the main seismic reflection dataset. Since the seismic vibrator is a surface source, seismic energy must propagate through unconsolidated, weathered, near-surface material. Such material often has a significantly lower seismic velocity than deeper, consolidated rock, and any lateral variations in the seismic properties of the near-surface 'low velocity layer' (LVL) can be manifested in the travel-time of the deeper seismic reflections. These effects can then impact the resolution and visibility of subtle reflection targets, leading to potential problems during interpretation. Seismic refraction methods are therefore one useful means of characterizing the properties of a near-surface LVL.

Seismic refraction acquisitions was conducted on the Boot Camp with, primarily, an hammer source and a Geometrics GEODE recording system.

We used two different kind of geophones, the cable connected and wireless.

We checked the data quality during the acquisition and at the end of the day we met in a classroom to discuss about the interpretation of the raw data.

Electrical/Electromagnetic Surveying (ERT and FDEM)

Electrical and electromagnetic methods involve measuring and interpreting the way that electrical current interacts with subsurface materials. Most often, those interpretations are based on variations in the vertical and spatial distribution of electrical resistivity (or, inversely, electrical conductivity) in the ground.

Clearly, electrical resistivity shows significant variability across the spectrum of geological materials. However, with respect to the materials we were likely to encounter on Boot Camp, resistivity was chiefly a function of the water content of the ground, and of the salinity of that groundwater.

Electrical methods involve passing electrical current through the subsurface, and measuring the voltage at some observation point. According to Ohm's Law, the resistance (R) of a body is given by the ratio of the change in measured voltage (ΔV) to the input current (I). However, resistance is a scale-dependent quantity, and the geometry of the current propagation path must be accounted for to obtain the scale-invariant resistivity, ρ. As such, the interpretation of resistivity data is a non-unique inversion problem.

Electrical acquisitions was conducted on the Boot Camp with ABEM Terrameter SAS 4000 Electrical Resistivity Tomography equipment, using different survey arrays (Wenner, Schlumberger).

While also sensitive to distributions of electrical resistivity, electromagnetic (EM) methods invoke Maxwell's equations to induce electrical current within the subsurface, and use properties of an associated electromagnetic (EM) field to infer electrical resistivity. That EM field can be characterized in either the frequency domain or the time domain, and it is worth considering the differences in these two styles.

FDEM systems derive an estimate of electrical conductivity by comparing the phase lag between the inducing electromagnetic field and that induced in any subsurface conductor. FDEM systems typically comprise two coils, which serve as the transmitter and the receiver of the two EM fields. These coils can be internal to some equipment housing, or external. A greater separation between coils increases the depth to which the FDEM equipment is sensitive, although changing the orientation of the coils (and therefore the orientation of the inducing EM field) also changes depth sensitivity.

FDEM acquisitions was conducted on the Boot Camp with DUALEM 421 frequency-domain EM equipment.

Reference source:

Bootcamp Pre-Reading Materials 2015.

Gravity Surveying (Measurement of local gravity field)

Measuring the variation of the gravity field provides information about the density variations within the Earth. The gravity method is commonly used to map variations in depth to discontinuities within the Earth – the Moho, the basement, the base of near-surface material. It is often used at large scales combined with seismic data to map deep geological structures and occasionally at smaller scales for engineering scale problems.

On the Boot Camp, we made measurements along the seismic reflection profiles and other tracks/roads in the area. At this scale (~1,500 m long lines), the structures associated with the oil field will only have a very smooth effect on the gravity field, which may be seen as subtle curvature of the Bouguer anomaly along the profile.

Gravity acquisitions was conducted on the Boot Camp with Scintrex CG-5 Autograv system.

Reference source:

Bootcamp Pre-Reading Materials 2015.

Ground Penetrating Radar (High - resolution imgaing of shallow subsurface structure)

Ground-penetrating radar (GPR) is a near-surface survey technique which, under favorable circumstances, offers the highest resolution imaging of all geophysical methods. However, the detailed resolution that it offers comes at the limitation of shallow depth-penetration and it is rare in typical survey settings that GPR will propagate to greater depth than 20 m. As such, it has few direct applications in hydrocarbons imaging, but we will use it in an engineering context to image buried infrastructure which may represent risk to seismic operations.

The GPR system used on the Boot Camp is a pulseEKKO PRO. The system can be equipped with antennas with a range of operational frequencies, but we have access to antennas of centre-frequency 250 MHz and 500 MHz.

Reference source:

Bootcamp Pre-Reading Materials 2015.

DIARY LOG (in Italiano)

Sabato 21

L'intera giornata passata in viaggio. In particolare sono serviti 2 aerei e 2 treni per raggiungere l'accomodation site in Olanda. Tralasciando un piccolo "problema" con la coincidenza del secondo treno, quanto è fico poter viaggiare su un intercity ed avere il wi fi gratuito?

Arrivato presso l'hotel ho subito ricevuto il KIT EAGE: Zainetto, caschetto, borraccia e giubbino dell'alta visibilità con tanto di logo.

Scendo per la cena e trovo un accozzaglia promiscua di gente intenta a divorare il dolce. Mi presento e subito l'organizzatrice provvede a farmi portare la cena. Ho così occasione di scambiare 2 chiacchere con l'élite del Boot Camp.

Mangiato velocemente raggiungo i miei compagni di sventura presso il "pub". Il tempo di bere qualcosa e si torna in stanza. L indomani sveglia alle 6.30.

In stanza faccio conoscenza dello scozzese che condividerà con me la stanza. Studente della magistrale presso l'università di Aberdeen. Un paio di parole ed è tempo di chiudere gli occhi.

Domenica 22

Si parte. Subito dopo la colazione ci ritroviamo in una meeting room per conoscere gli aspetti principali del camp e inoltre le regole generali di sicurezza (HSSE).

Il pullman è fuori ad attenderci. Si partecipa al Geological Field Trip. Le guide? Il TNO.

Vengono da subito creati dei gruppi. Io finisco con un tedesco, una francese ed una ungherese (non è l'inizio di una barzelletta). La giornata è incentrata anche su un esercizio sulla stima dello STOIIP. Riusciamo a fare quasi tutto correttamente, ma ci perdiamo nel calcolo finale, tra ordini di grandezza vari e stime non del tutto corrette.

Si ritorna. Ma la destinazione è a Nordhorn (in Germania). Un nuovo "hotel". In stanza si aggiunge un ulteriore membro scozzese. La location è stupenda da vedere ma forse pecca in abitabilità.

Fatto più grave tra tutti: la cena… alle 18.30.

Si formano i gruppi per i giorni seguenti ed io capito con gente che non conosco ancora (una olandese, un venezuelano, un tanzaniano ed uno scozzese).

Una birretta per conoscere qualcun altro (un ceco, un francese, un greco, due nigeriani, un tedesco, mamma mia quanta gente) e si va a letto. Sveglia alle 6.00.

<u>Lunedì 23</u>

La giornata inizia molto presto. Rapida colazione e via al campo petrolifero. Una buona mezzoretta si assiste tutti assieme alla lezione sulla HSSE. Ci dividiamo e io, con il mio gruppo, mi devo preoccupare di preparare una linea di 1.5 km di sismica a riflessione. Facciamo conoscenza con il gruppo che si occuperà di fare da supervisor per la sismica a riflessione (la DMT).

Nel pomeriggio un tour all'interno del campo petrolifero con dei professionisti della Wintershall.

Tornati in albergo dopo la cena ed una doccia, si partecipa ad una lezione sulla sismica a riflessione, con tanto di esercitazione sui dati grezzi acquisiti in giornata.

Martedì 24

Sismica a rifrazione a 96 canali. Ci guida il Dr. Roger Clark dell'università di Leeds. Si stende l'array e via di martellate. Con 2°C un po' di esercizio fisico non fa mai male!

Nel pomeriggio arrivano i geofoni wireless. E chi li aveva mai visti? Spiegazione su questi gioiellini e dopo la disposizione lungo lo stesso array si torna a smartellare… I miei muscoli sono piaciuti parecchio e sono di fatto diventato la sorgente ufficiale della giornata!

La sera, dopo la solita cena alle 18.30, check dei dati ed esercizio. Non ci sono voti e non si vince nulla, semplicemente ci si diverte imparando.

Mercoledì 25

Giornata umida...bagnata. Piove. Ma nulla ci ferma.

Oggi si torna a fare la sismica a riflessione e si cambia disposizione dei geofoni. 1.5 km con geofoni a passo 0.5 m. Numeri da capogiro. Per fortuna la sorgente è il nostro caro minivib, sarò un ottima sorgente ma sarebbe disumano energizzare fino a 1500 metri.

Dopo pranzo si parte con l'acquisizione e via al centro controllo per il check della qualità del dato. Probabilmente sono stato fortunato visto che la pioggia è sempre più intensa ed io ho la possibilità di stare all'asciutto.

Giovedì 26

La giornata di oggi prevede di mattina sismica a riflessione e di pomeriggio metodi elettrici magnetici. La mattinata viene dedicata al riposizionamento dei geofoni su un altra linea per permettere ai ragazzi del gruppo pomeridiano di poter acquisire. Nessuno protesta, anzi...ormai siamo un folto gruppo di amici e non si può fare a meno di scambiarsi favori.

Nel pomeriggio faccio conoscenza dei due supervisor che ci seguiranno in acquisizioni FDEM ed ERT. Olandesi dell'università di Amsterdam. Molto simpatici. Mi armo di forza e coraggio e impugno una delle due estremità del DUALEM 421 (ben 4m di lunghezza). Dopo una passeggiatina di acquisizione (500 m circa) si modifica l'array ERT e si lancia l'acquisizione Wenner.

Venerdì 27

L'ultimo giorno di attività. Siamo tutti felici ma al contempo tutti tristi. Oggi mi toccano gravimetria e gpr. La mia squadra non va al campo petrolifero...il target è archeologico. Che figata. Mi ritrovo a fare esperienze che neanche immaginavo.

Il tempo è caino: pioggia e vento mettono a dura prova la nostra resistenza, ma soprattutto le prestazioni del caro Scintrex CG5. Si pianifica l acquisizione con il supervisor Roman Pasteka (università di Bratislava), ma siamo già consapevoli di non poter ottenere risultati gratificanti. Di fatto durante la giornata si riescono a collezionare giusto una ventina di stazioni.

Il GPR va strisciato nella stessa area della gravimetria. Le antenne non temono acqua o vento quindi si va spediti grazie al supporto del supervisor James Booth. Con una 500MHz siamo riusciti a visualizzare qualcosa di simpatico. Sembrano esserci strutture circolare con diametro circa di 3m. Saranno antiche colonne? Chi lo sa... bisognerebbe scavare e noi non abbiamo i mezzi!

Di sera un simpaticissimo BBQ viene organizzato. Piove ma a nessuno importa. Si chiacchera e si canta e si balla e si mangia e si scambiano i contatti e si fanno promesse per futuri incontri...

Sabato 28

Il giorno del ritorno. E non sono da solo. Quanto meno fino all'aeroporto. Viaggia con me una giovane professionista della TOTAL, compagna di ventura durante il Boot Camp.

L'esperienza è stata dunque ***FANTASTICA***. A partire dalla possibilità di avere tra le mani, nello stesso luogo e nel giro di una settimana tanta strumentazione geofisica differente; passando per la disponibilità dei vari supervisor per approfondire le conoscenze sulle varie metodologie, nonché le problematiche relative a target tanto diversi. Ovviamente il tutto è stato condito dalla condivisione con ragazzi più o meno miei coetanei, universitari e giovani professionisti, su tematiche geofisiche annaffiate da litri e litri di sana birra tedesca!