Tieferlegen des Abscherhorizonts wird der Deckenbau durch Faltung mit großen Amplituden überprägt (siehe Abb. 2). Dieser Prozess geht mit der Ablagerung der syntektonischen Gosau Sedimente einher und beginnt unmittelbar nach der Überschiebung der Inntaldecke, ab dem Coniac (Ortner 2001, 2003). Eine ähnliche Faltungssequenz wurde auch im Rätikon beobachtet, wo südöstlich der zentralen Synklinale Faltenzüge mit Facing nach unten auftreten.

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Different generations of banded iron formations (BIF-s)

Sosnicka, M.

AGH University of Science and Technology,
Faculty of Geology, Geophysics and Environmental Protection,
Department of Economic and Mining Geology,
Al. Mickiewicza 30, 30-059 Krakow, Poland;
sosnicka@agh.edu.pl

Precambrian banded iron formations (BIF) are widely distributed in the world. In Europe, they occur within shields of the East European craton. Purpose of the presentation is the comparison of Olenegorsky and Kryvyj Rig iron deposits situated within banded iron formations. They represent different generations of iron ore accumulation.

The origin and evolution of the metamorphosed deposits are very intricate. They experienced many stages starting from deposition, deformation and metamorphism, post deformation processes, metasomatism, hydrothermal alteration and weathering.

The Kryvyj Rig iron-formation is situated in eastern Ukraine within the Ukrainian Shield, whereas the Olenegorsky deposit is located in the central part of the Kola Peninsula, within the Baltic Shield. Both of the deposits are associated with Precambrian Shields but the geological setting of each is quite different. The geology of Kola Peninsula is associated with exotic terranes and collage tectonics. Banded iron formations occur within Kola-Norwegian terrane, in the Imandra iron ore-bearing region. The largest accumulations of economic iron deposits are situated in the south-western part of the terrane within the Main Priimandrovskaya Structure, which is a part of Olenegorsky greenstone belt. Kryvyj Rig Belt, situated in Dniepropetrovsk province, is related to the boundary of two geoblocks, marked by Kryvyj Rig-Kremenchuk fault. Kryvyj Rig deposit is about 2390 Ma, whereas the age of Olenegorsky deposit ranges from 2790 to 2760 Ma. Olenegorsky iron ore deposit is classified as Algoma type, in contrast Kryvyj Rig deposit belongs to the Superior type or the transitional type between both mentioned.

The precursors of Kryvyj Rig deposit are rocks mostly of sedimentary origin, whereas Olenegorsky deposit is build mainly of primary volcanic associations. Common feature in both profiles is occurrence of basement complex, composed of granites and migmatites. Different degree of metamorphism makes analysis and comparison of the profiles difficult. Olenegorsky deposit beds, called iron quartzite formation, consists of metamorphosed rocks of primary terrigenous origin. From the bottom, the formation includes arkoses, mafic volcanic rocks, iron quartzites and andesitic porphyries, tuffs, picritic flows. Equivalent high-grade metamorphic rocks to precursors are: biotitic gneisses, amphibolites, iron quartzites, aluminous gneisses, leptites and gedritites. Kryvyj Rig formation is divided into three main deposit beds called: lower, middle and upper. The lower and upper deposit beds are built of arkosic sandstones, schists and conglomerates. The middle is mostly composed of jaspilites and schist.

The research revealed that the iron ores exploited in both deposits show different granulation and mineralogical composition. Common banded iron formations features as macro banding, micro banding and high iron content are preserved in both types of iron ore. The Kryvyj Rig ore bodies contain two types of ore: rich ore and poor ore. The rich one contains more than 46 % of iron, whereas the iron content of the poor one is about 20-45 % of iron. The highest content of iron in ore, exploited in Olenegorsky open pit, is more than 37 %. There are also zones of poor iron content. The Kryvyj Rig iron ore is fine laminated and is comprised of alternating microbands of hematite, magnetite, martite, red jasper or „Tiger Eye“. In contrast, the Olenegorsky iron ore is composed mainly of magnetite, andradite and white to gray quartz bands. Both deposits contain minor quantities of sulphides and native elements. Kryvyj Rig iron ore contains sulfur in amount of 0,16 %, whereas the Olenegorsky deposit sulfur content is 0,009 %. The iron ores are of a good quality and are not contaminated with arsenic, phosphorus, or manganese.

The comparison of Archean and Proterozoic iron formations lead to conclusion that there are many differences and similarities between them. The main difference is geological setting and the principal similarity is ore banding. The Precambrian iron deposits are economically very important, because they are the major source of global iron.

Fault drag as a tool to identify fault segments and rule out tectonic inversion: a case study from the Vienna Basin

Spahic, D., Exner, U. & Grasemann, B.

Department for Geodynamics and Sedimentology, University of Vienna, Althanstrasse 14, 1090 Vienna

Using an industrial 3D seismic dataset from the central part of the Vienna Basin (Austria), we investigate fault growth by studying marker horizons within the hanging wall and footwall of the Markgrafneusiedl fault, a large-scale normal fault. The fault geometry and throw distribution of individual horizons show a remarkable variability, both along strike and along dip of the fault. Quantification of this large-scale fault drag allows identification of linked individual fault segments constraining the fault evolution.

Near-fault deformations are common phenomena that frequently occur in both extensional and compressional tectonic systems. Two fundamentally different explanations for the origin of fault drag in extensional regimes have been proposed. One very popular model explains the development of rollover anticlines by the existence of a listric normal fault (e.g., McClay & Scott 1991), which connects a steep upper part of a fault to a low angle detachment horizon at depth. Alternatively, the occurrence of reverse fault drag, comprising an anticlinal structure in the hanging wall and a synform in the footwall of a planar normal fault, has been explained by the decrease of displacement from the center to the tips of the fault surface both laterally and vertically (Grasemann et al. 2005). The latter model, which we favor for the interpretation of structures along the Markgrafneusiedl fault, additionally offers a solution to the observation of „compressional“ structures, i.e. folds surrounding fault planes with normal displacement, which in conventional tectonic models require for a regional compressional phase and basin inversion.

The investigated Markgrafneusiedl fault, crosscutting the clastic Miocene sedimentary pile deposited from Carpathian up to the Pannonian age, represents the southeastern border of the Matzen oilfield. At depth, the fault displaces seismic horizons up to the decollement level, with a maximum throw of ~400 m.

In order to document marker horizons for the analysis of fault drag, several most distinctive seismic reflectors were mapped throughout the entire 3D time-migrated seismic cube. In addition to the two well-documented stratigraphic markers, the chronostratigraphic framework was constrained at the basis of seismic calibration with numerous deep exploration boreholes. After seismic amplitudes were mapped in TWT by using a Landmark/ Geographix software, a depth conversion applying a generalized equation assuming an exponential increase of seismic velocity with depth was calculated in the 3D modeling software Gocad (Paradigm). This conversion ensured a better geometric representation of the fault drag geometries, additionally enabling a 3D displacement measurement in meters.

The additional documentation of fault drag permits a more detailed identification of individual fault segments, which cannot be so accurately achieved by using conventional parameters, such as fault dip, azimuth and throw. Moreover, using a complex 3D attributes derived from a 3D surfaces, we identified that the two scale-dependant generations of a fault drag correspond to a similar number of fault segment orders. Thereby, it is possible to constrain the relative timing of faulting with respect to coalescence of individual initial fault segments. Therefore, a study of a fault drag around complex mature fault surfaces can help to identify pre- and post-coalescence time of differently sized fault segments, and to distinguish fault drag along normal faults from folding due to tectonic inversion.

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Frontier seismic exploration in the North Atlantic

Spitzer, R.

OMV Exploration & Production,
Trabrennstrasse 4-6, A-1200 Wien

The North Atlantic continental margin was formed by continental break-up in the early Tertiary, which led to stretching and thinning of the continental lithosphere, accompanied by massive magmatism, producing flood basalts which covered pre-existing sediments and extensive igneous intrusion. Industry and university goals coincide in the North Atlantic region where low frequency seismic energy, together with high-density, long-offset, single-sensor recordings, are used to penetrate volcanic overburdens and illuminate both the deep structure of magmatic margins and potential hydrocarbon-bearing sub-basalt sediments.

This paper briefly summarizes the seismic results of the iSIMM project (integrated seismic imaging of magmatic margins). The industry-university collaboration aimed to develop a structural model from seabed to Moho to image the stretched crust and the extruded, intruded and underplated igneous material, and sediment structures in this area within and overlain by the basaltic sequences of stacked flows up to several kilometers thick.

The present paper further highlights the implications of basalt-tuned acquisition and processing techniques for OMV, which is successfully exploring the remote region of the North Atlantic margin. Examples illustrate developments in intra- and sub-basalt seismic acquisition (e.g., over-under shooting) and consequences for processing such target-focused seismic data sets (e.g., LF-processing).

Marine Isotope Stage 3 recorded in palaeolake sediments in the Eastern Alps

Starnberger, R.[1], Rodnight, H.[1], Reitner, J.M.[2],
Reimer, P.[3] & Spötl, C.[1]

[1] Institute of Geology and Palaeontology, University of
Innsbruck, Austria, Innrain 52, 6020 Innsbruck;
reinhard.starnberger@uibk.ac.at;
[2] Geological Survey of Austria, Neulinggasse 38, 1030 Vienna;
[3] School of Geography, Archaeology and Palaeoecology,