

## **8<sup>th</sup> Jordanien International Mining Conference**

**19.09. to 21.09.2017 Ammann - Jordan**

### **Natural Resources: Projected Investment, Reality and Aspirations**

Dr.-Ing. Marc Dohmen, Aachen

Dohmen, Herzog & Partner GmbH

52070 Aachen, Germany

Soerser Weg 9

Phone.: +49241 99 0000 0

Fax: + +49241 99 0000 91

E-Mail: [marc.dohmen@dhp-gmbh.de](mailto:marc.dohmen@dhp-gmbh.de)

Internet: [www.dhp-gmbh.de](http://www.dhp-gmbh.de)

## **Advanced Technologies in digital 3D-Surface, -Deposit und -Mine-Modelling**

### **Abstract**

Nowadays digital data management in the mining industry becomes more and more important to optimize the modelling, planning and operation process. New developments, increasingly efficient hardware combined with professional database- and web-technology open new opportunities in several mining segments. The lecture will give some practical examples from surveying, deposit and mine modelling to show advanced technologies in the aggregate and oil shale industry.

### **UAV Survey**

The surveying of quarries is increasingly being carried out by drones. Due to the rapid development of Unmanned Aerial Vehicles (UAV) and photogrammetry software solution, this modern surveying technic is becoming also interesting for the raw material industry.

With a ground resolution of up to 3 cm point distance and a flight time of less than one hour it is possible to measure even large-scale areas quickly and accurately. Especially inaccessible areas of the quarry or difficult outside conditions can be easily detected. Moreover a better documentation with geo-referenced aerial photographs of the mining area and progress compare to conventional GPS surveying is possible.

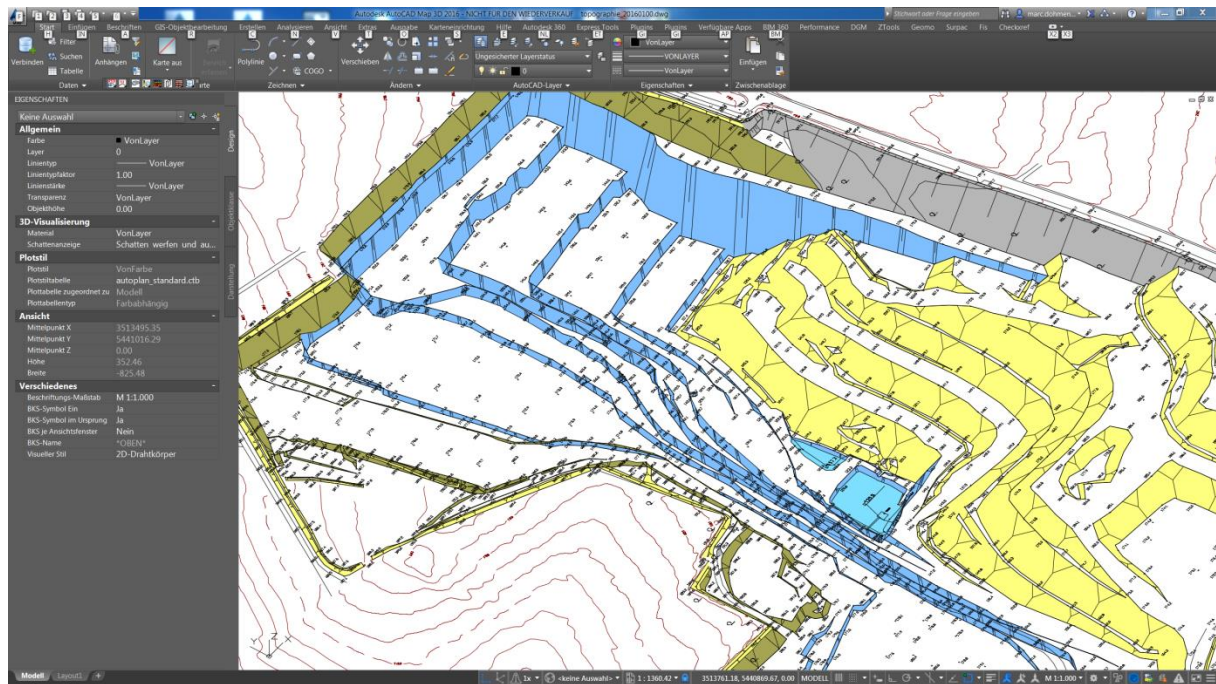
A detailed calculation of a digital terrain model (DTM) is carried out on the basis of a dense 3D point cloud calculated by the photogrammetric application. It should be mentioned that the photogrammetric application depicts the total surface of the image-recorded areas. Therefore, points in areas of high and dense vegetation as well as buildings and installations will be calculated as well. These points can not be used for terrain modeling and must be removed manually or with special point filters.

The most important challenge today is the re-presentation of the survey data as a topographical layout in maps. The results of the photogrammetric evaluation consist, in addition to the aerial image, of a three-dimensional point cloud. This point cloud has to be transferred to a topographical string model with slopes lines, roads, buildings boundaries and other terrain objects such as pathes and water areas.



A fast automated edge detection of slope top and bottom edge with signature calculation is not included in many photogrammetric software products. Therefore elaboration and manual post processing on the PC is required. But there are new developments for automatic slope detection algorithm.

In addition to terrain surface modeling, point clouds can also be used for the three-dimensional digitization of geological structures and peculiarities, as far as they are open and visual on the slopes/benches to update the deposit model.



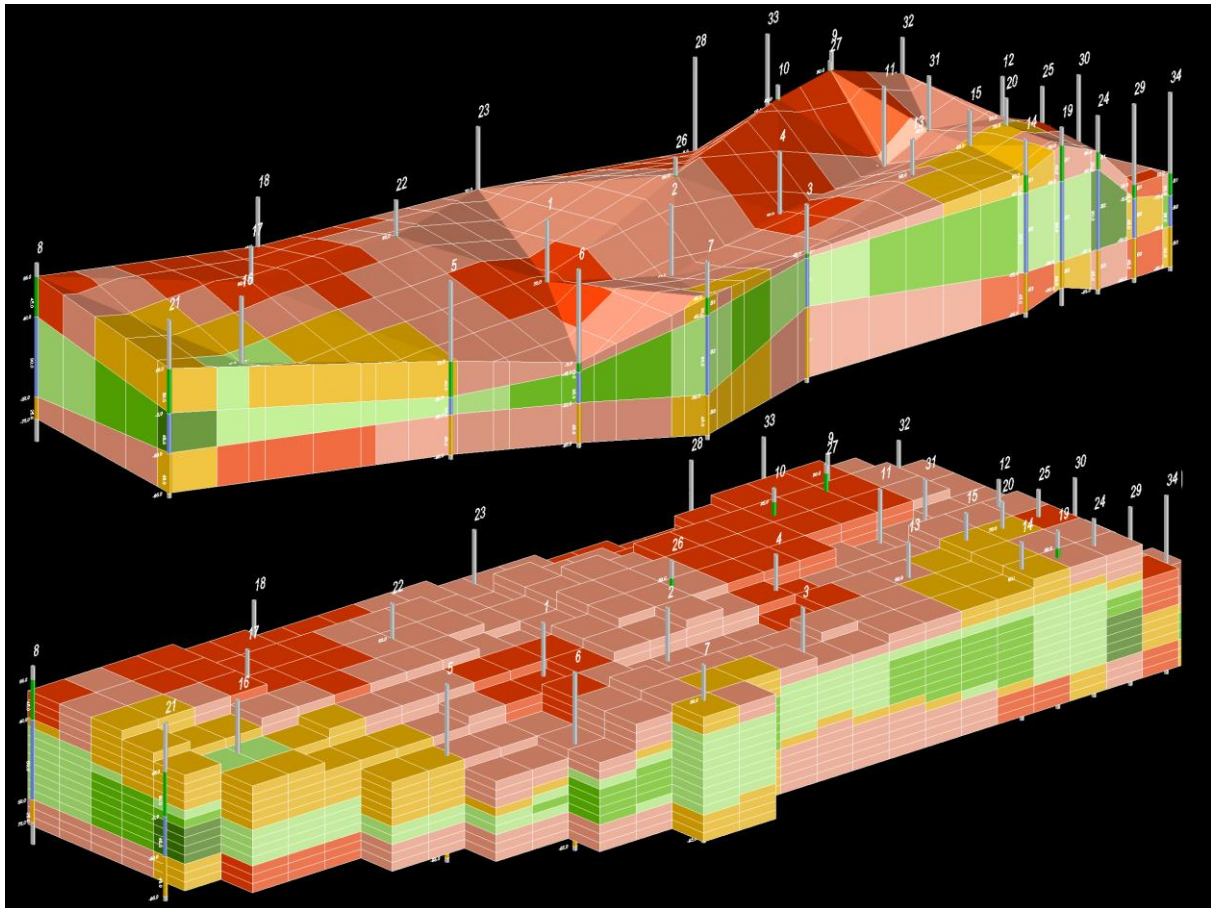
## Deposit Modelling

—The deposit is the base of the raw material extraction and production. Therefore the deposit modelling process for quantity and quality is very important to get realistic values for the planning process. Modern software applications like AutoPLAN collect first all description and analysis data of exploration boreholes and other geological information in a central SQL-database. The data import, editing, visualization and reporting can be managed by a web browser. Based on this data a 3D geometric model will be developed by different interpolation methods.

AutoPLAN / GEO														
AutoPLAN GEOMO EE/AMCO - DHP Production DB														
Map	Data	Features	Analysis	Samples Analysis	Well Drillings	Planning	Instructions	Loading Points	QC	Mischbett	Reports	Administration		
Countries	Plants	Drill Holes	Drill Hole Sections	Features of Section	Drill Hole Overview	Drill Hole Documents	Import	Export						
Country	JOR - Jordan	Plant	Wadi	Drill Hole Group	Drill Hole Area	Drill Hole	Kind of Features							
Drill Holes														
Drill Hole Sections														
Features of Section														
Drill Hole Overview														
Drill Hole Documents														
Import														
Import Drill Hole Basic Data														
Import Drill Hole Section Data														
Bohrloch-Dokumente														
Export														
Export Drill Hole Basic Data														
Export Drill Hole Section Data														
Drill Hole Section	Start Depth [m]	Final Depth [m]	Image	Index	Index 2	Oil [%]	Heat of combustion Lowest estimate [MJ/kg]	Heat of combustion Lowest estimate from I.C.A.T. [MJ/kg]	Heat of combustion Lowest estimate from Index Average [MJ/kg]	Material	Index 7	Index 5	Subunit	
Import Drill Hole Basic Data	▶ ATTE 81-116	61.620	62.150	Anschl. E1	FOR		3.5			oil shale m.	iron parts	GuG-GS		
Import Drill Hole Section Data	▶ ATTE 81-117	62.150	62.550	Anschl. E1	FOR			3.516		oil shale m.	iron parts	GuG-GS		
Bohrloch-Dokumente	▶ ATTE 81-118	62.550	62.790	Anschl. D1	FOR					oil shale m.	iron parts	GuG-GS	Do2	
Export	▶ ATTE 81-119	62.790	62.870	Anschl. D1	FOR					oil shale m.	iron parts	GuG-GS	Do2	
Export Drill Hole Basic Data	▶ ATTE 81-120	62.870	63.030	Anschl. D1	FOR					oil shale m.	iron parts	GuG-GS	Do2	
Export Drill Hole Section Data	▶ ATTE 81-121	63.030	63.180	Anschl. D1	FOR					oil shale m.	iron parts	GuG-GS	Do2	
	▶ ATTE 81-122	63.180	63.250	Anschl. D1	FOR					oil shale m.	iron parts	GuG-GS	Do2	
	▶ ATTE 81-123	63.250	63.560	Anschl. D1	FOR					oil shale m.	iron parts	GuG-GS	Do2	
	▶ ATTE 81-124	63.560	63.860	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-125	63.860	63.920	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-126	63.920	65.240	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-127	65.240	65.350	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-128	65.350	65.410	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-129	65.410	65.730	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-130	65.730	65.820	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-131	65.820	66.210	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-132	66.210	66.310	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-133	66.310	67.160	Anschl. D1	FOR		5.51			oil shale m.		GuG-GS		
	▶ ATTE 81-134	67.160	67.320	Anschl. D1	FOR			3.081		oil shale m.		GuG-GS		
	▶ ATTE 81-135	67.320	67.480	Anschl. D1	FOR			3.061		oil shale m.		GuG-GS		
	▶ ATTE 81-136	67.480	67.720	Anschl. D1	FOR		4.392			oil shale m.		GuG-GS		
	▶ ATTE 81-137	67.720	67.810	Anschl. D1	FOR		4.392			oil shale m.		GuG-GS		
	▶ ATTE 81-138	67.810	68.230	Anschl. D1	FOR		4.392			oil shale m.		GuG-GS		
	▶ ATTE 81-139	68.230	68.330	Anschl. D1	FOR		4.392			oil shale m.		GuG-GS		
	▶ ATTE 81-140	68.330	68.780	Anschl. D1	FOR		4.392			oil shale m.		GuG-GS		
	▶ ATTE 81-141	68.780	69.280	Anschl. C	FOR		4.515			oil shale m.		GuG-GS		
	▶ ATTE 81-142	69.280	69.380	Anschl. C	FOR		4.515			oil shale m.		GuG-GS		
	▶ ATTE 81-143	69.380	69.490	Anschl. C	FOR		4.515			oil shale m.		GuG-GS		
	▶ ATTE 81-144	69.490	69.590	Anschl. C	FOR		4.515			oil shale m.		GuG-GS		
	▶ ATTE 81-145	69.590	69.990	Anschl. C	FOR		4.515			oil shale m.		GuG-GS		
	▶ ATTE 81-146	69.990	71.200	Anschl. C	FOR		7.740			oil shale m.		GuG-GS		
	▶ ATTE 81-147	71.200	71.300	Anschl. C	FOR		7.740			oil shale m.		GuG-GS		
	▶ ATTE 81-148	71.300	71.460	Anschl. C	FOR			6.320		oil shale m.		GuG-GS		
	▶ ATTE 81-149	71.460	71.620	Anschl. C	FOR			6.320		oil shale m.		GuG-GS		
	▶ ATTE 81-150	71.620	72.480	Anschl. C	FOR			6.320		oil shale m.		GuG-GS		
	▶ ATTE 81-151	72.480	72.600	Anschl. C	FOR			6.320		oil shale m.		GuG-GS		
	▶ ATTE 81-152	72.600	73.300	Anschl. C	FOR			6.320		oil shale m.		GuG-GS		
	▶ ATTE 81-153	73.300	73.630	Anschl. C	FOR			6.334		oil shale m.		GuG-GS		

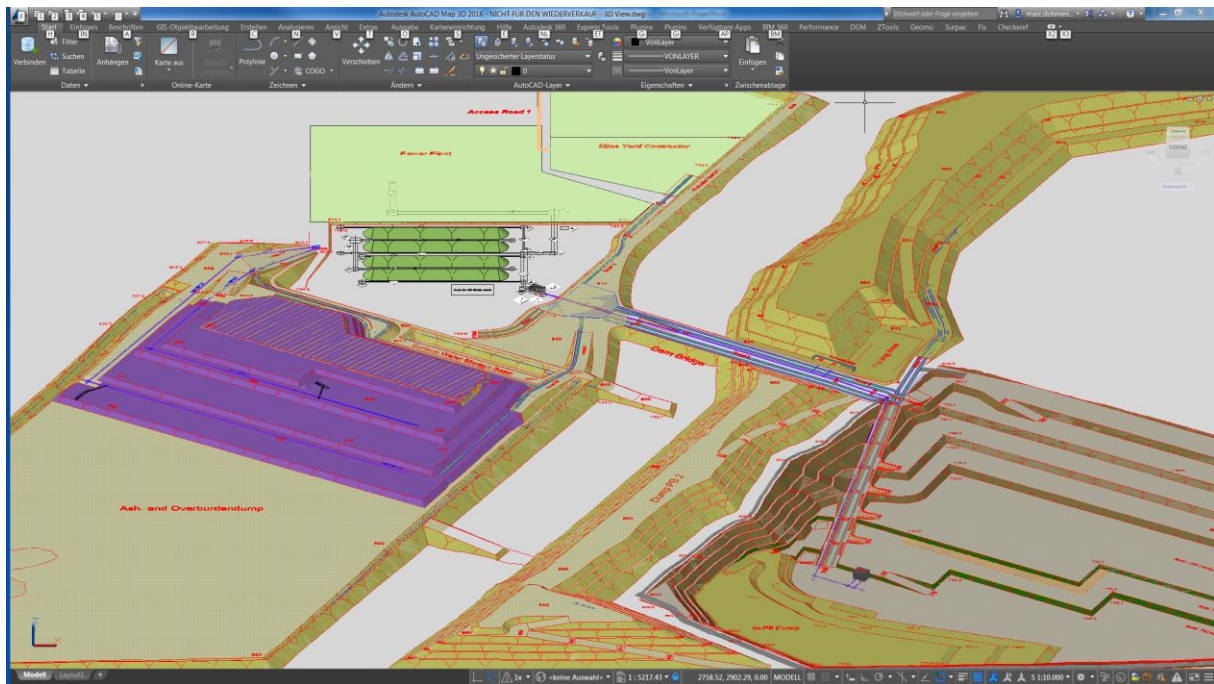


The type of the modelling methods becomes important and depends on the nature of the deposit. For sedimentary deposits like limestone and oil shale a layer-bound/stratigraphic block modelling is suitable. Contrary to conventional block models the stratigraphic block model considers arbitrary formed layer boundaries and thus simulates the real deposit conditions which have been developed during sedimentation of the material bearing seams.



## Mine Planning

Based on the topographical survey and the geological deposit model the mine and dump design will be developed by the mining engineer. To calculate the mined quantity and quality a full 3D mine model has to be developed. Additional engineering parameters such as mining levels, slope inclination/heights, primary crusher positions, conveyor belt relocations or ramp systems are topics which have to be considered during the mine and dump planning.



One of the key topic for inhomogeneous deposits is the optimised blending calculation of different loading points to ensure the quality supply and economic efficiency of the short term mining operation which can be solved by a derived mine block model from the geological block model.