

Intelistrata: a System for Stratigraphic Interpretation of Well Logs*

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Abstract

The petroleum exploration workflow usually involves a multitude of data intensive tasks. For instance, the reconstruction of the stratigraphic history of a given area of interest might require description and interpretation core, logs and seismic data; a resource-consuming task. A huge research effort has been invested in search of intelligent software system that could to automate or semi-automate some these tasks. In answer to that, we developed the Intelistrata system, a complete software framework capable of recognizing stacking pattern and stratigraphic surfaces in gamma ray well logs. It takes a digitalized a gamma ray log as input and recognizes the presence of sequences and parasequences along the log. A sequence is a series of genetically related layers whose limits are defined as a response to a relative sea level fall. Parasequences, on the other hand, indicate small cycles of sea level variation within sequences. From a technical standpoint, the Intelistrata interpretation engine innovates by integrating signal processing and semantic reasoning techniques to produce a coherent interpretation of the data. The signal-processing module employs wavelet and movable means algorithms to segment the gamma ray signal, based on an expected feature length informed by the geologist. The extracted features are then fed to a semantic reasoning engine able to recognize and filter which of the features match the conceptual definitions of sequence and parasequence. The conceptual definitions consist of visual knowledge models elicited from an expert in sequence stratigraphy; i.e., a domain ontology. The visual knowledge model represents the stratigraphic features that will be recognized in the gamma ray logs; it tries to incorporate the knowledge the geologist applies when individualizing the geological limits. The generated result is a semantically rich description of the well log in terms of stratigraphic features. The Intelistrata system has been validated with a total of 3.2 km of gamma ray logs from the USA (Book Cliffs, Utah) and Brazil (Caçapava do Sul, RS), comparing generated interpretation with the expert interpretation. In brief, the system demonstrated a mean hit ration to 75% per well for sequences, while generating only about 10% of false positives per well. Intelistrata is now being integrated to the Strataledge® system for sedimentary facies description of cores and outcrops.

Reference Cited

Goldberg, K., 2001, The paleoclimatic evolution of the Permian in the Paraná Basin in southern Brazil: Ph.D. Dissertation, Department of Geophysical Sciences, University of Chicago, 267 p.



Intelistrata

A system for stratigraphic interpretation of well logs

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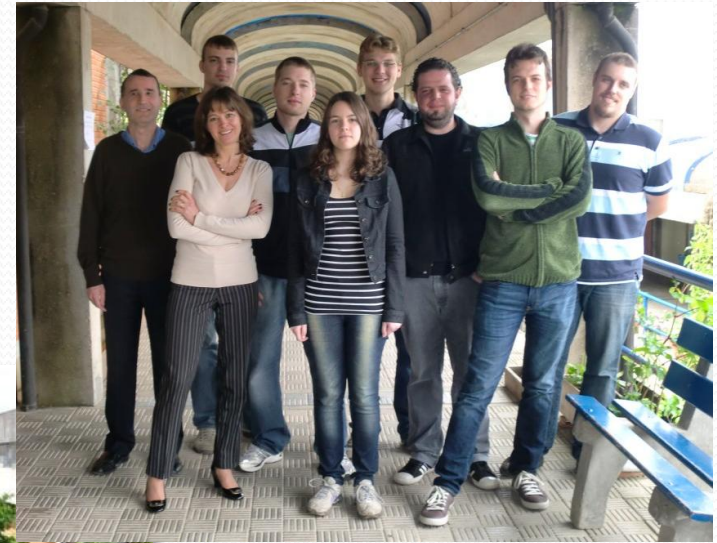
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The BDI Group



Porto Alegre

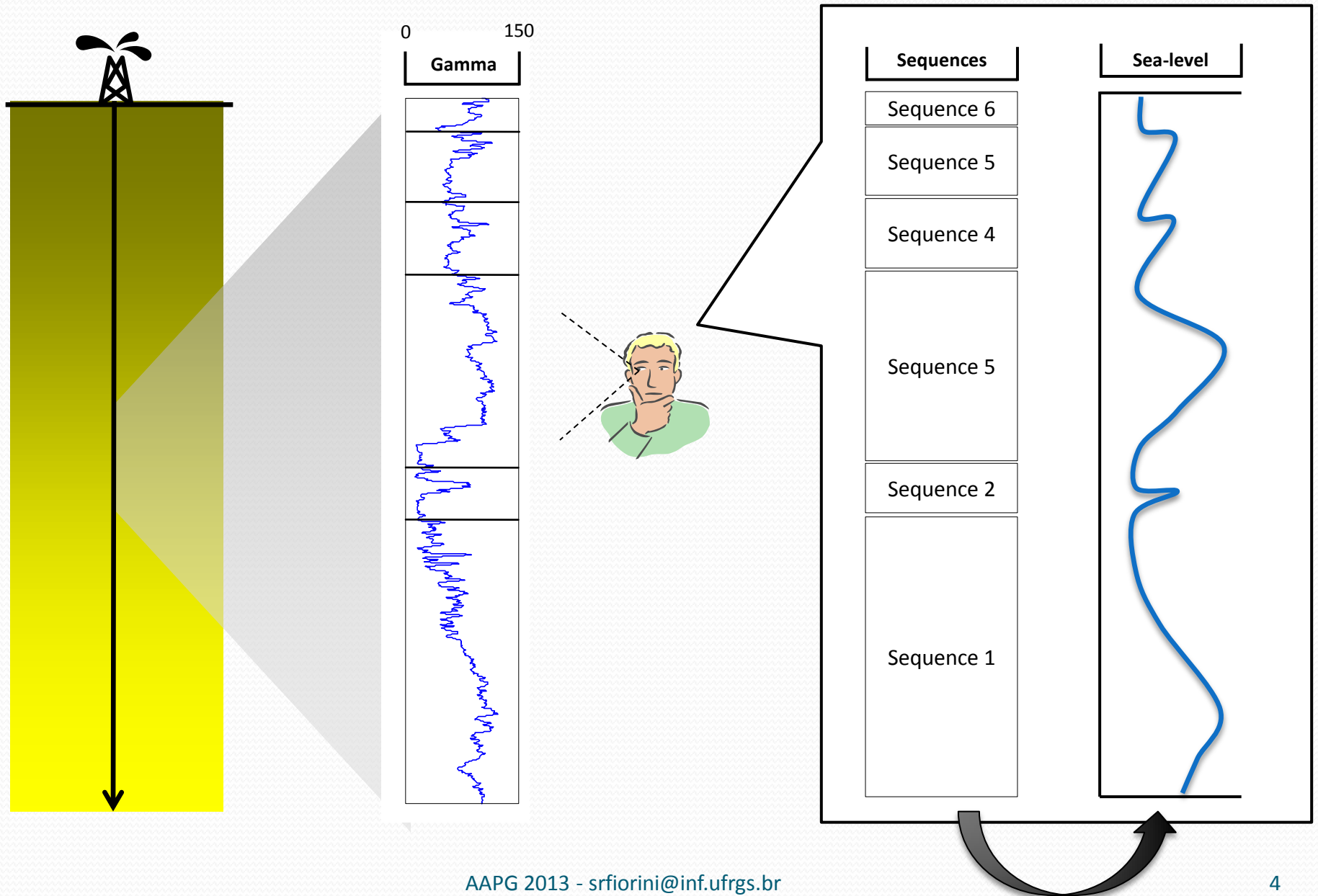


- Knowledge Representation and Reasoning
- Petroleum Geology

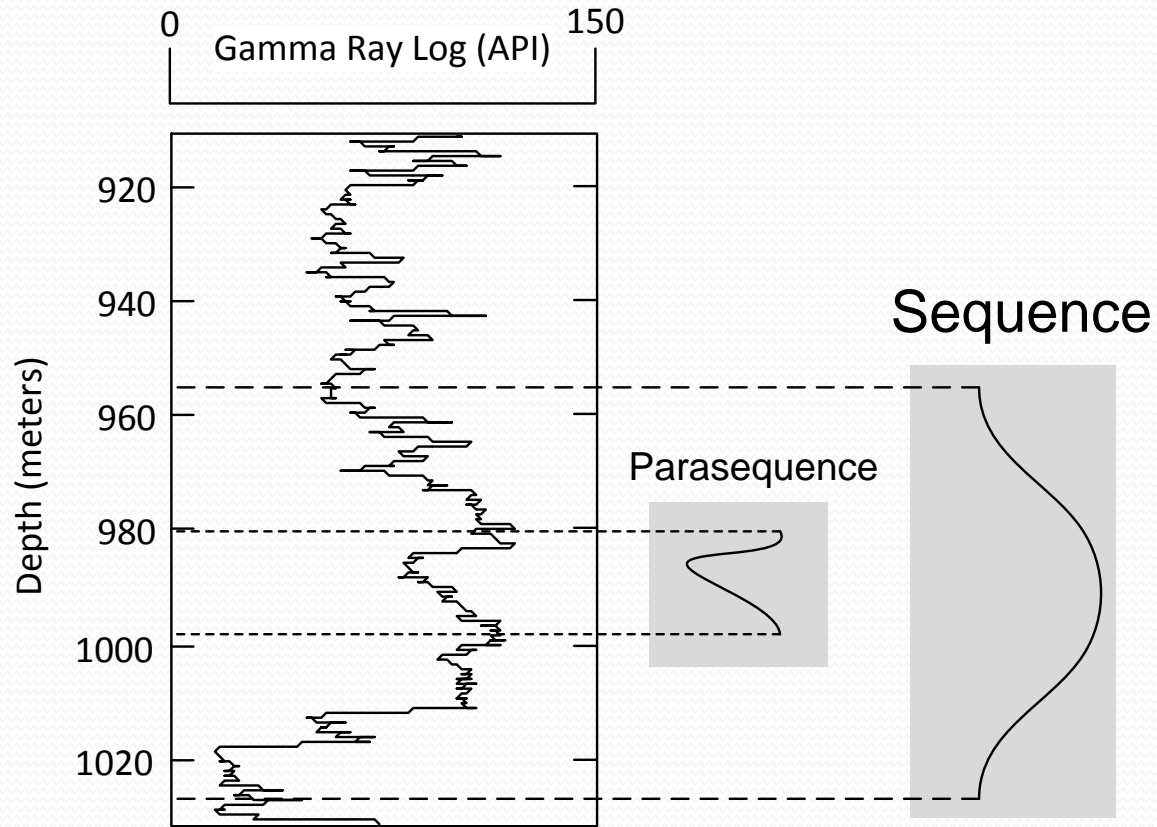
BDI Group

- Past: Petrography
 - Project Petrographer
 - Petrographic description and interpretation of clastic and carbonate reservoir rocks
- Spin-off: **ENDEEPER** **PETROLEGE®**
- Present: Stratigraphy
 - Knowledge modeling
 - Stratigraphic Interpretation

Stratigraphic Interpretation



Stratigraphic Interpretation



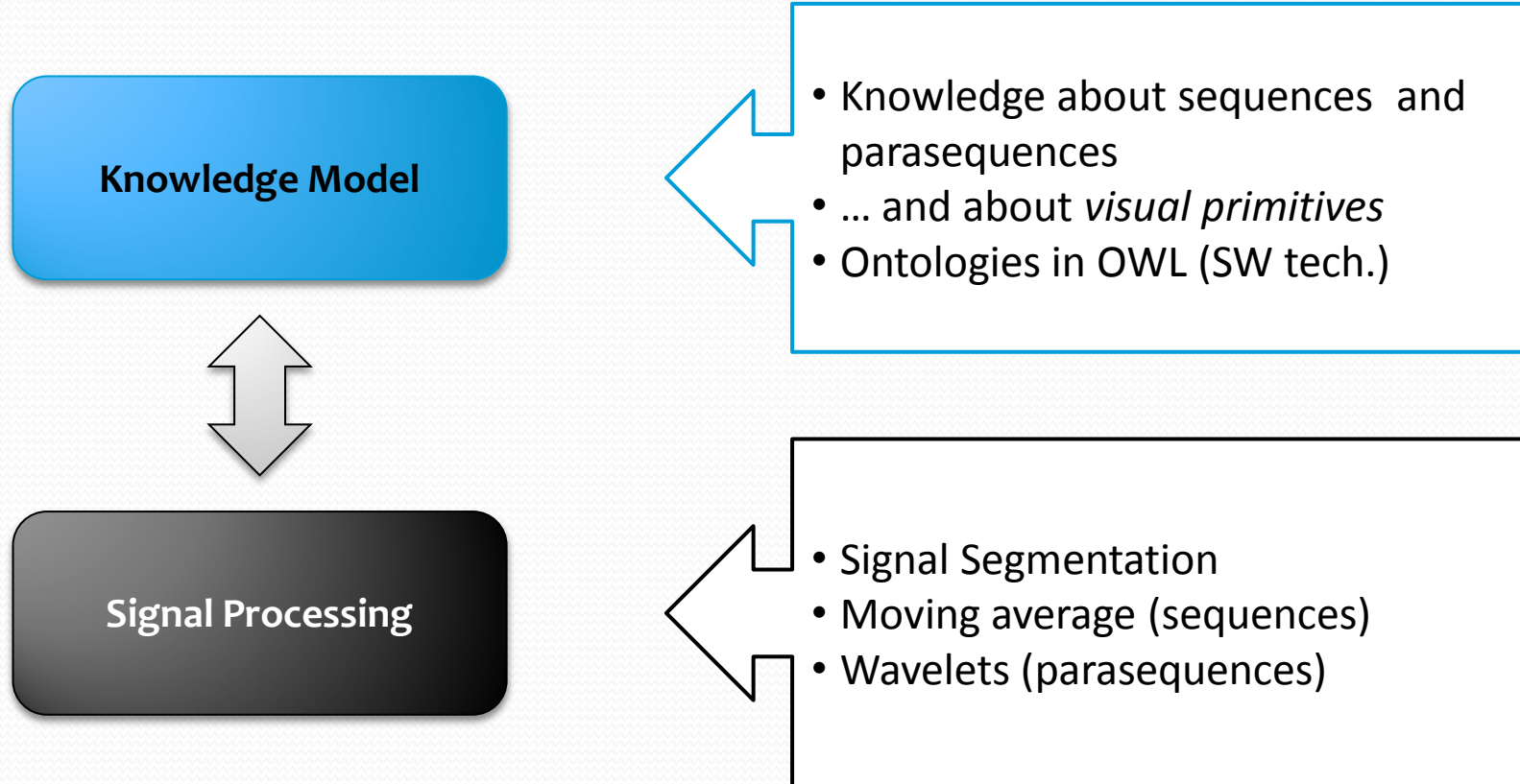
The Problem

- **Sequence and parasequence** interpretation
- Gamma-ray logs
- **Placing all those limit is a time consuming task!**

Intelistrata System

- It semi-automates stratigraphic interpretation
- **Inputs:**
 - Digital log gamma ray log
 - Expected mean sequence length
 - Expected mean parasequence length
- **Output:**
 - Suggestions of sequence and parasequence limits on the log
- Semantic image interpretation

Semantic Image Interpretation



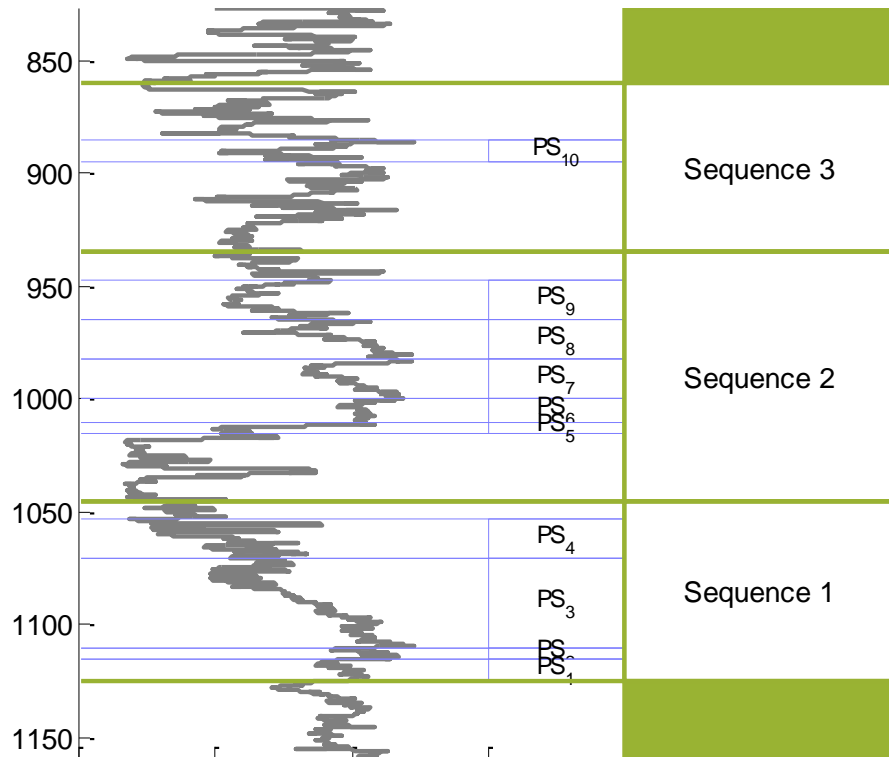
Validation – Data

- Two datasets
- Set 1: **Two well log sections** from **Book Cliffs, Utah, USA**
 - Publicly available at the Department of Natural Resources, Utah, USA
 - Expert interpretation as reference interpretation
- Set 2: **Four well log sections** from the Paraná Basin, **southern Brazil**.
 - Data is publicly available at the Geological Survey of Brazil (CPRM)
 - Reference interpretation by Goldberg (2001)
 - Unfortunately, no parasequences!

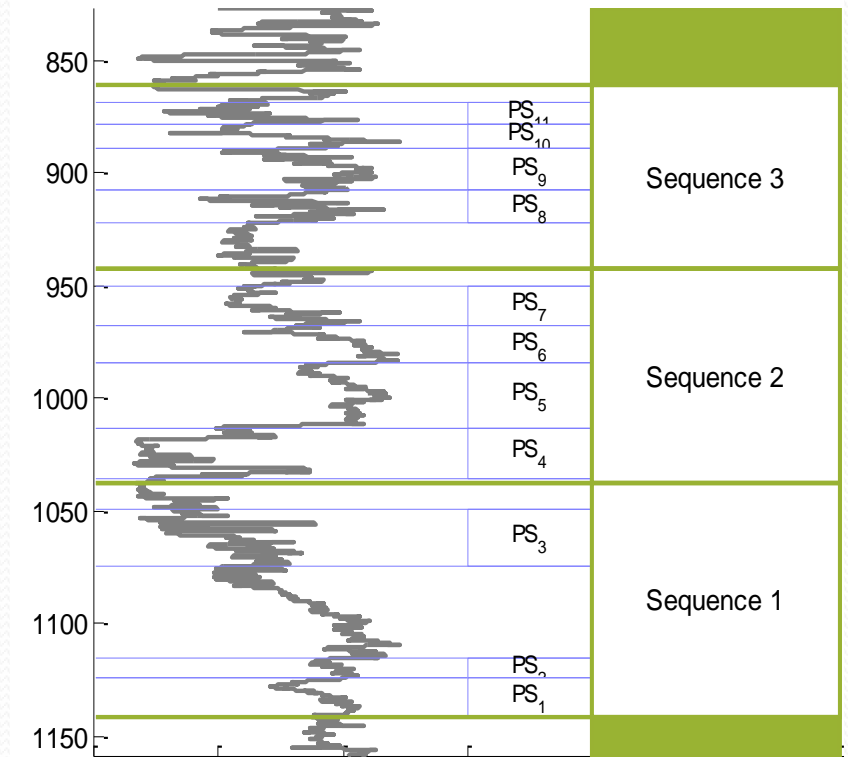
K. Goldberg, The paleoclimatic evolution of the Permian in the Paraná Basin in southern Brazil, Thesis (Ph.D.), University of Chicago, Dept. of the Geophysical Sciences, Chicago, USA, 2001.

Intelistrata – Example Results

Well: *Rattlesnake 2-12*



Interpretation by the expert



Interpretation by the system

Detailed results – Sequences

Test Data

Results

	Well	Length (m)	# Sequences by the expert	True positive	False Positive (noise)
Set 1	Rattlesnake 2-12	332m	3	3 (100%)	0
	Sego Canyon nº2	336m	2	2 (100%)	0
Set 2	CA-03	389m	3	3 (100%)	1
	CA-87	654m	5	2 (40%)	4
	CA-79	899m	6	4 (66%)	0
	CA-53	639m	5	3 (60%)	0

Detailed results – Parasequences

Test Data

	Well	Length (m)	# Parasequences
Set 1	Rattlesnake 2-12	332m	10
	Sego Canyon nº2	336m	6

Results

True positive	False Positive (noise)
4 (40%)	7
4 (66%)	7

Next Steps

- Integration with other systems
- Integration of different types of logs (resistivity, sonic, ...)
- Integration with lithological information