Shaliness @model

Mathematical model of rock shaliness.

The shales contain much higher concentration of radioactive minerals comparing to clean sands and carbonates (see **Table 1** below).

This is why the most common way to quantify the shale content is the intensity of the natural gamma-ray (GR) emission.

The fist step is to normalize the actual GR-tool readings GR_{log} to the reference values in clean rocks GR_m and pure shales GR_{sh} which is called Shale Index:

(1) $$I_{GR}(l) = \frac{GR_{log}(l) - GR_m}{GR_{sh} - GR_m}$$

where l – along-hole depth.

The model parameters GR_{sh} and GR_m are calibrated for each facies individually.

The shale Index I_{GR} is varying between 0 (for non-shally rocks) and 1 (for pure shales) but the actual shaliness may behave non-linearly between these extremes (especially for shallow, young reservoirs).

This can be calibrated based on the available core data.

The table below summairzes some popular shaliness models:

#	Equation	Author	Rock Type	Correlation database
1	$V_{sh} = I_{GR}$			
2	$V_{sh} = 0.083 \cdot (2^{3.7 I_{GR}} - 1)$	Larionov (1969)	Tertiary Jurassic rocks	West Siberia
3	$V_{sh} = 1.7 - \sqrt{(3.38 - (I_{GR} + 0.7)^2)}$	Clavier (1971)		
4	$V_{sh} = \frac{I_{GR}}{3 - 2 I_{GR}}$	Stieber (1970)		
5	$V_{sh} = 0.33 \cdot (2^{2 I_{GR}} - 1)$	Larionov (1969)	Older Rocks	West Siberia

The graphic image of different shales volume models is brought on Fig. 1.

Table 1. GR values for popular minerals

	Rock Type	GR, API
1	Halite (NaCl)	0

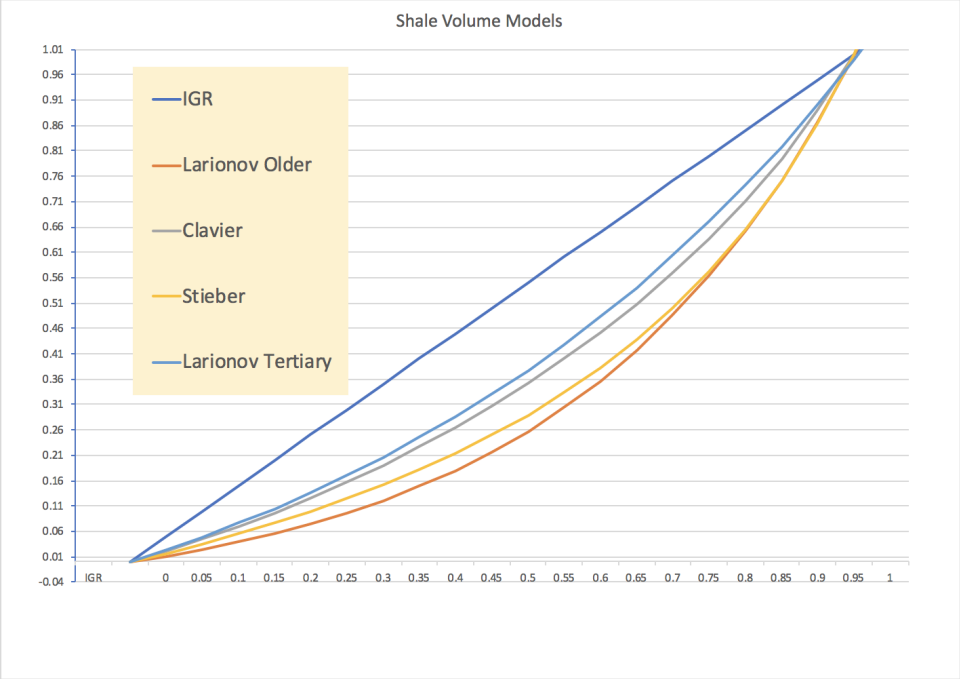

Fig. 1. Shale Volume Models.

2	Coal	0
3	Limestone	5 – 10
4	Sandstone	10 – 20
5	Dolomite	10 – 20
6	Shale	80 – 140
7	Mica	100 – 170
8	Silvite (KCl)	500

References