Mapping Tools Applied to Reservoir Efficiency Index (REI) Evaluation at Prospect/Basin Scale*

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Search and Discovery Article #41164 (2013)
Posted July 31, 2013

*Adapted from extended abstract prepared in conjunction with poster presentation at AAPG Annual Convention and Exhibition, Pittsburgh, Pennsylvania, May 19-22, 2013, AAPG©2013

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Abstract

The efficiency of a reservoir is a function of three main factors: the depositional environment, the initial mineralogical composition, and the post-depositional evolution during burial. The Reservoir Efficiency Index (REI) is a quantitative indicator of the quality of a clastic reservoir, it is calculated based on petrographic data, grain size distribution and sorting, cements amount and type, porosity, pore dimensions etc, using mathematical relationships for the determination of the relative importance of each parameter.

The mathematical expression of the REI is

$$REI = (CI + FI + PDI) * PC / 3$$

where CI, FI and PDI are partial indexes describing the distribution of the grains (Clast Index), the distribution of the cements (Filling Index) and the distribution of the pore dimensions (Pore Dimension Index). The average of these three indexes is then corrected for the porosity (Pore Correction). Moreover the Clast index is obtained as the multiplication of a component describing the type of grains (Initial Clast Index) and a component describing the size distribution (Grain Size Correction). Each of these indexes and corrections is calculated using the laboratory analysis of the samples. Figure 1, Figure 2, Figure 3, Figure 4, and Figure 5 describe in an intuitive way the behaviour of the various components of the final Reservoir Efficiency Index.

Plotting the REI values, obtained on samples from a variety of clastic reservoirs, against permeability, a good correlation is obtained, as seen in Figure 6. This is a verification of the reliability of the methodology of REI calculation.

Considering one reservoir unit, at each well location multiple measures of REI can be performed, giving as a general result an estimation of REI as an interval of values. To extrapolate the REI outside the wells, data analysis suggests that different variables, available outside wells, may have a direct/inverse correlation with the REI, these variables can be used as trends for the REI determination. These variables describe

sedimentological features (sand/shale ratio, reservoir thickness, …), diagenetic effects (depth, temperature, …), or in general may be a parameter that has a structural relationship with the reservoir quality as measured by REI.

Different mapping algorithms have been tested, in order to extrapolate data given as intervals using one or more trend variables given on map. In the presented case history, interval values of calculated REI at wells, and depth and temperature trends have been used. A particular type of kriging with uncertain data and external drift has been used. The algorithm tries in a first phase to estimate a REI point value for each well using the other wells and the trends. In a second phase these well REI values are extrapolated on the studied area using trends.

Figure 7 exemplifies the final REI map in a case where 5 input wells have been used to calculate point REI values and depth map of the reservoir as a trend for diagenesis and related reservoir quality.

This procedure evolves and completes the REI evaluation being able to extrapolate values calculated at wells over an area of interest at lead to prospect scale, depending on the availability of the data.

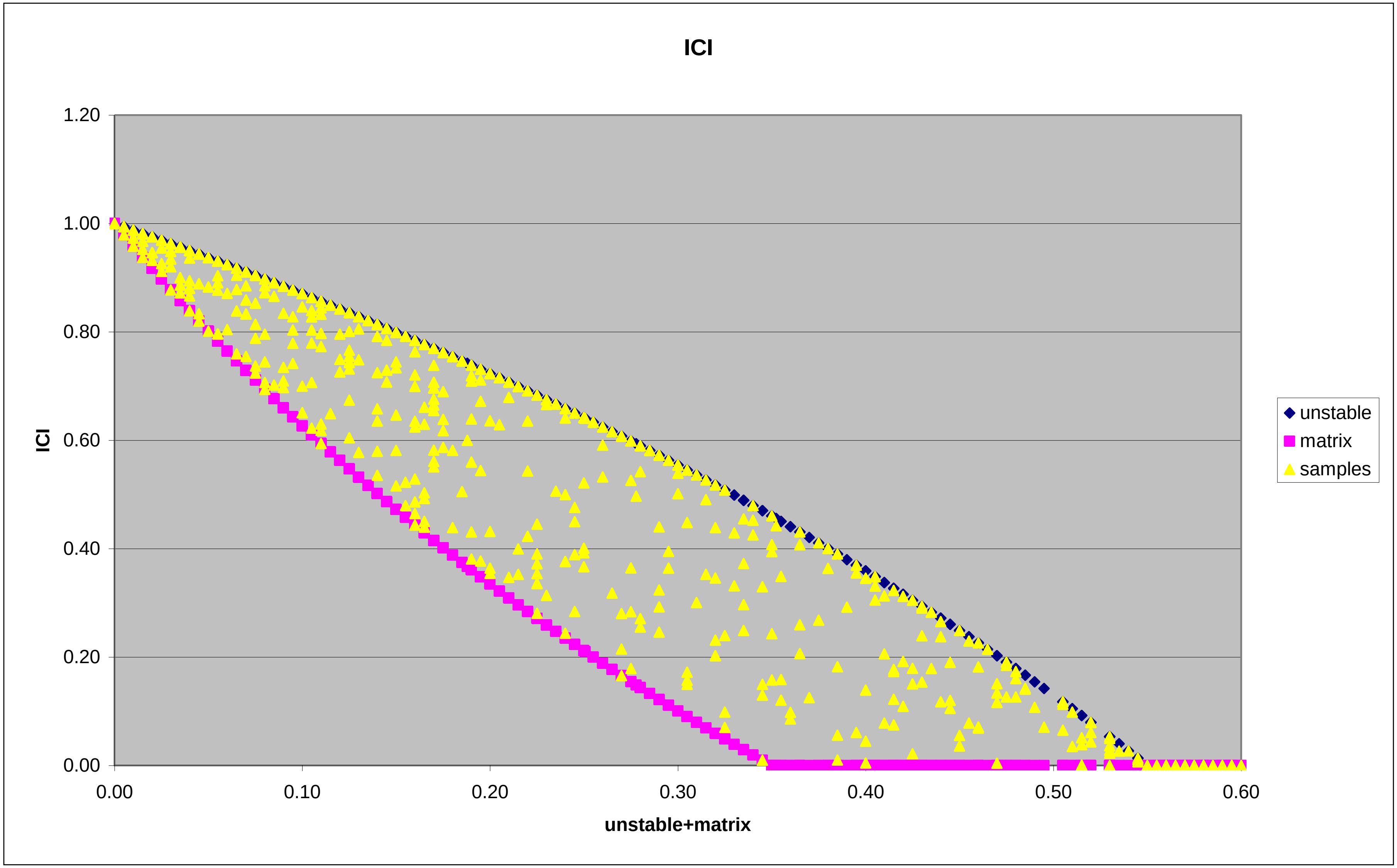

Figure 1. Initial Clast Index, calculated from grain mineralogy.

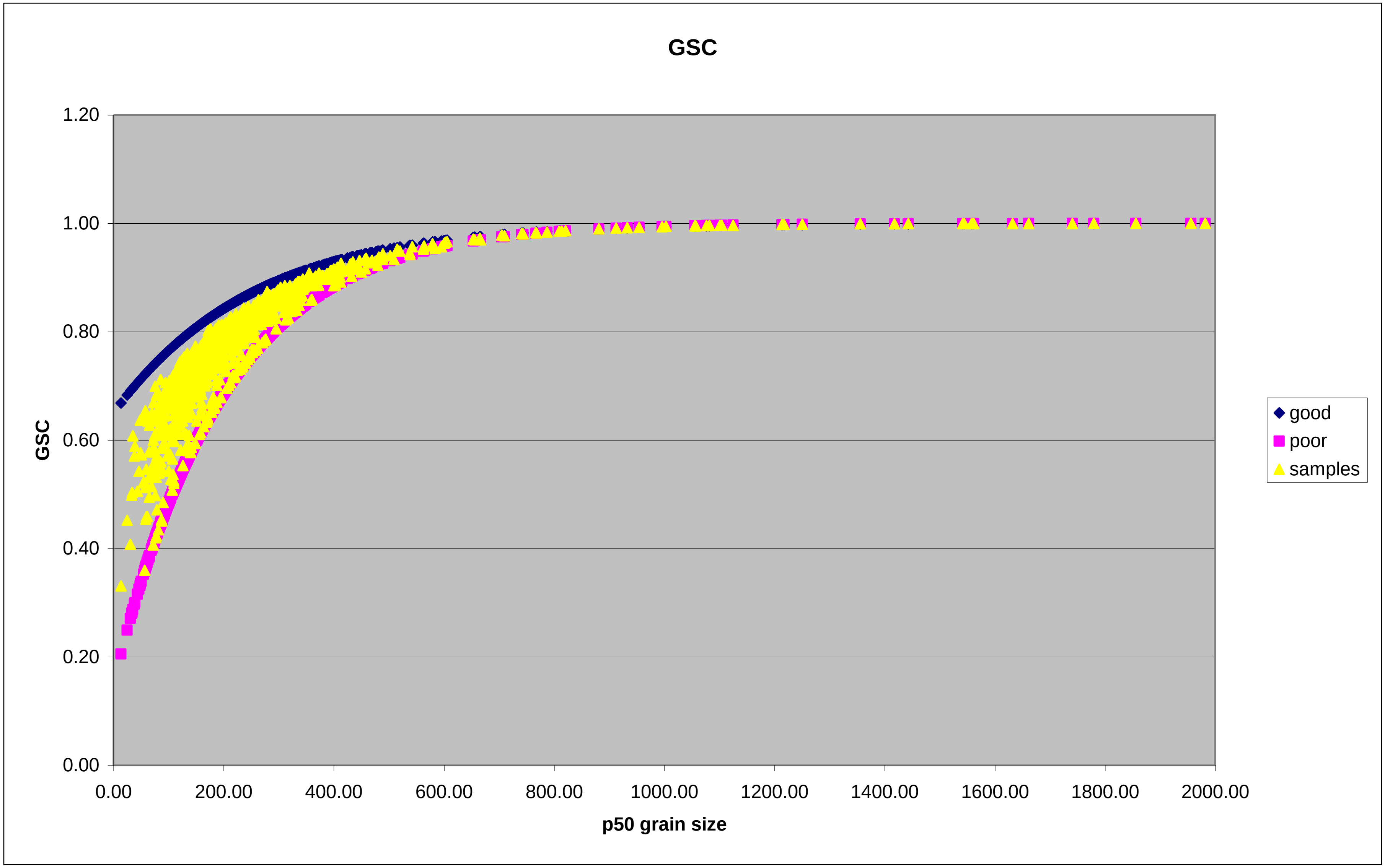

Figure 2. Grain Size Correction.

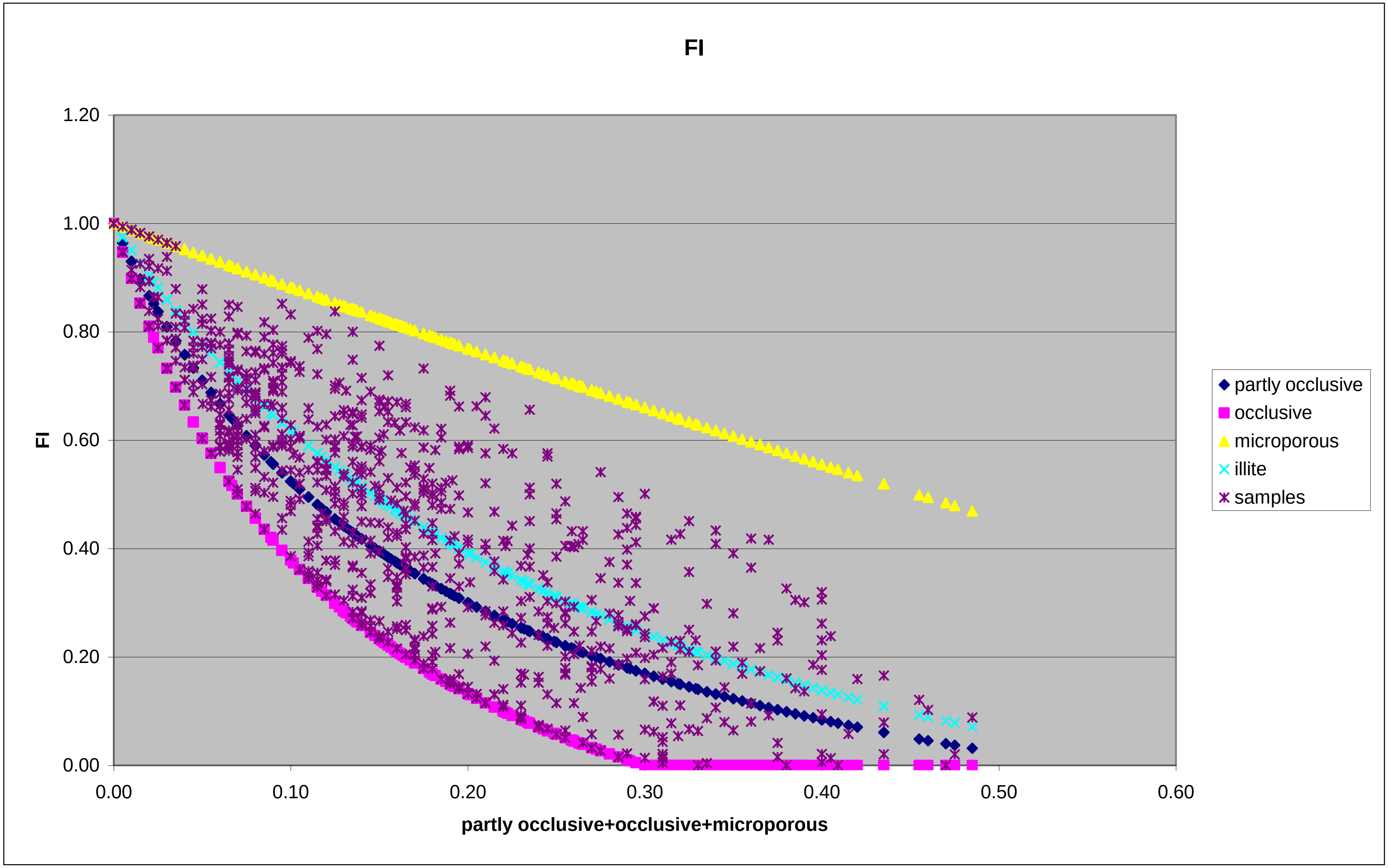

Figure 3. Filling Index, calculated from cements abundance.

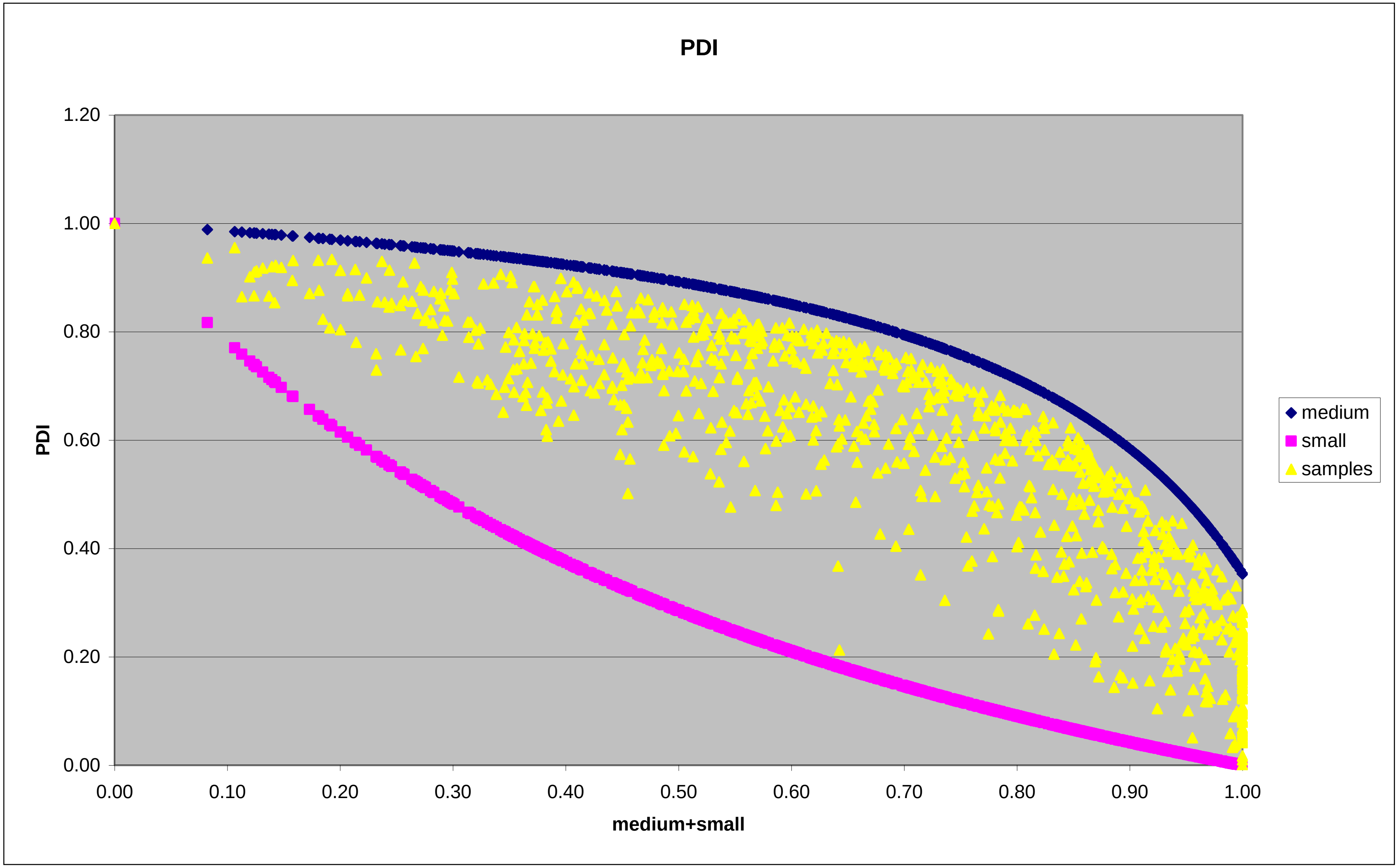

Figure 4. Pore Dimension Index, contains information of pores dimension.

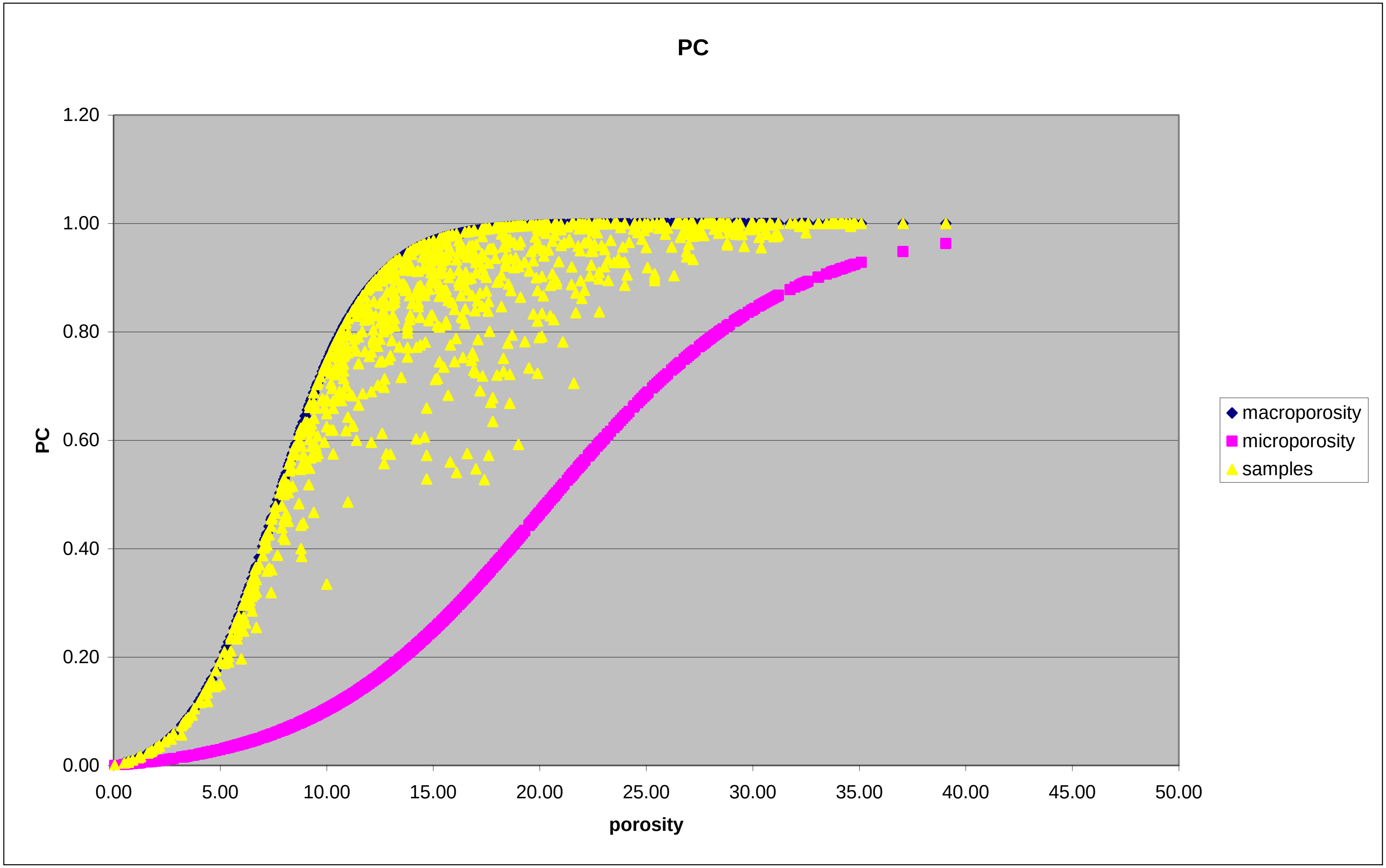

Figure 5. Porosity Correction.

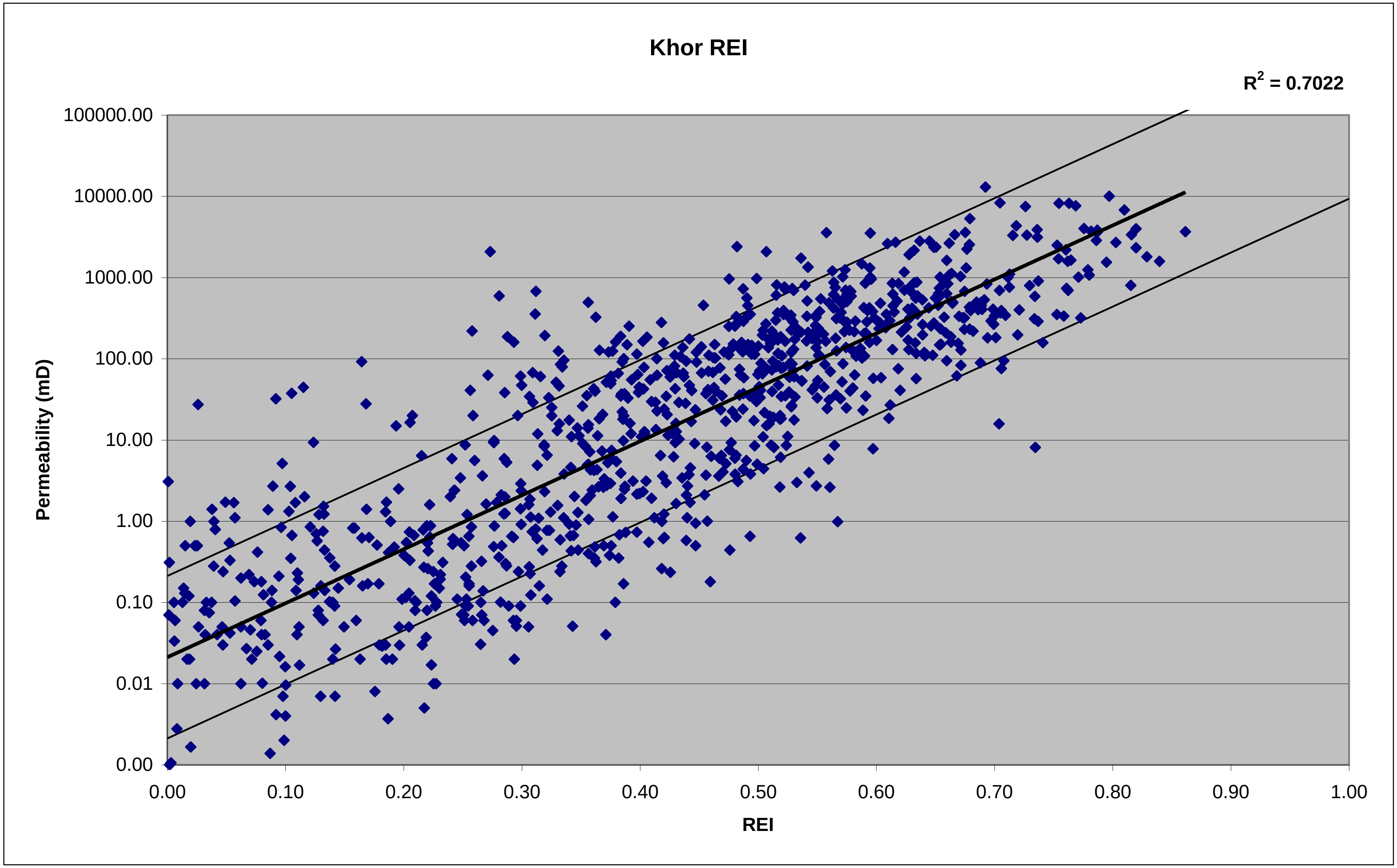

Figure 6. Plot of Permeability vs REI showing the good correlation between the two parameters.

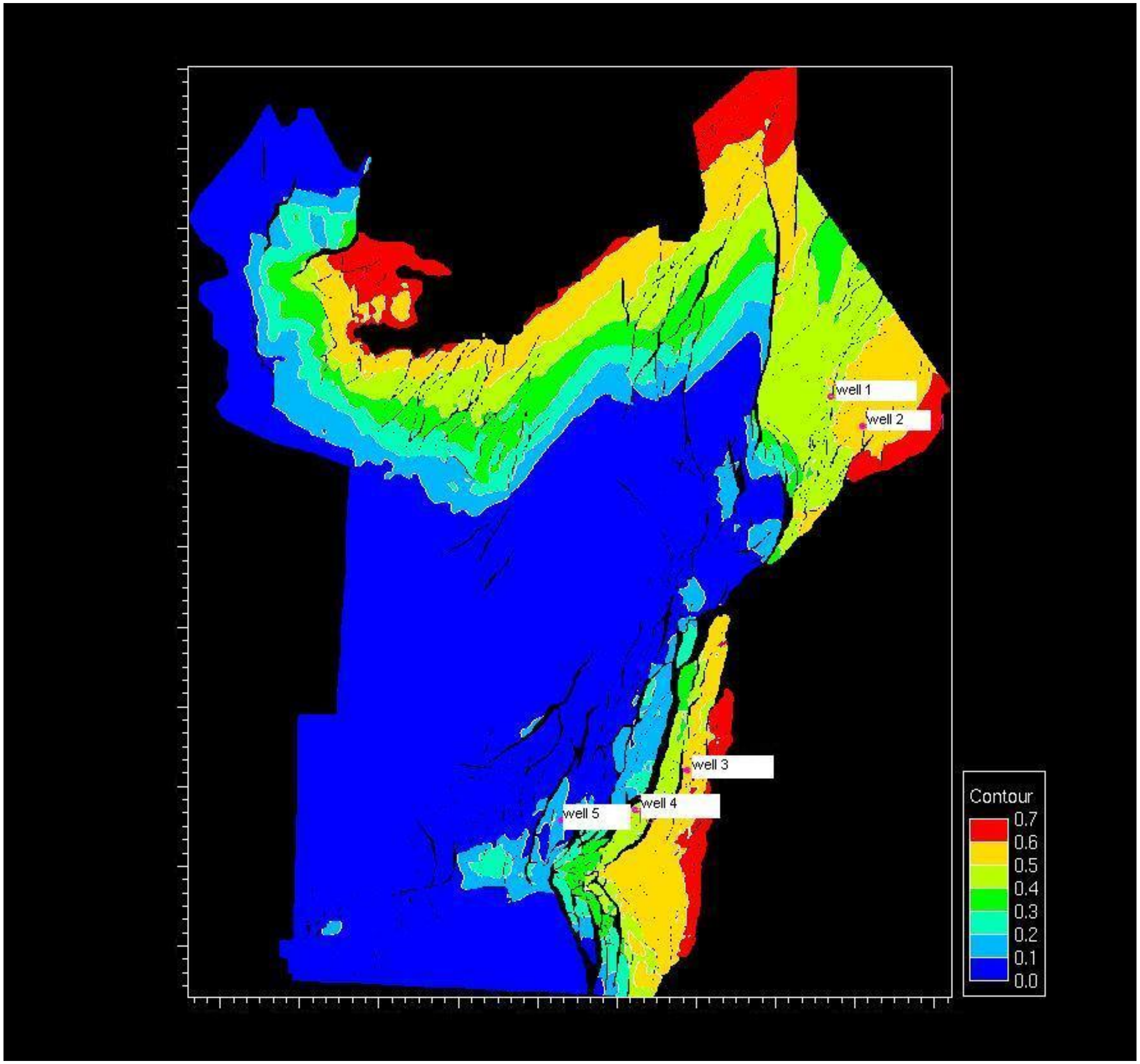

Figure 7. Example of REI mapping on an area using REI values at wells and depth as trend. Size of the map is approximately 180 km x-direction and 220 km y-direction.