Cambridge Carbonates Ltd

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Karst Fissure Analysis At Outcrop: How Representative are AOI Subsamples of the Wider Karst Fissure Population - The Big Picture

Analysis of Macrofractured Reservoirs

A major issue in the understanding and development of dual porosity systems in carbonate reservoirs is the evaluation of relative contributions from channel porosity (e.g. tectonic fractures or karstic fissures) and 'matrix'. This relationship is critical to the issue of the rate and duration of reservoir petroleum deliverability. Many erroneous assumptions are made in evaluation of opportunities where the reservoir is described as being 'fractured' with (for example) '14% porosity'. In such cases a better understanding is required in order to develop viable production and recovery strategies.

Commonly the only tools available are standard log suites which can give total porosities, but there are significant obstacles in subdividing this total into meaningful categories. Also for carbonate reservoirs, there may be a considerable range in size of features that are capable of production. In particular, and perhaps ironically, it is the largest features that prove to be the most difficult to characterise and capture. Because of this we have developed a system of characterising and quantifying porosity distribution from an imagelog/outcrop scale, via a whole-core/CAT Scan scale, down to petrographic and even SEM scale porosity. Each scale of measurement can be stitched together to give an overall picture of how the porosity network is developed within carbonate rocks.

Overleaf we present techniques that can be applied to the largest scales of measurement, in this case study, karstic fissures within an outcrop analogue on the Gargano Peninsula of Italy. Analysis of subsurface FMI logs can provide similar data to the subsampled quarry faces. Overall, in a subsurface context, the mean porosity present within the large karstic fissures can be calculated and compared to total log porosities to define the split between karstic fissures themselves vs. matrix porosity in the blocks between fissures. Clearly, this allows the calculation of an almost perfect sweep of the karstic volume, given optimum perforation and careful pressure management. It would indicate also, the volume of the pore network lying in-between karstic elements for which there would be significantly worse overall recovery at the same drawdown pressures. In addition, work on relevant outcrop analogues such as these, can highlight the natural variability in what is detected by different appraisal wells, and may highlight the relevance of a horizontal vs vertical well appraisal programme, in any reservoir development.

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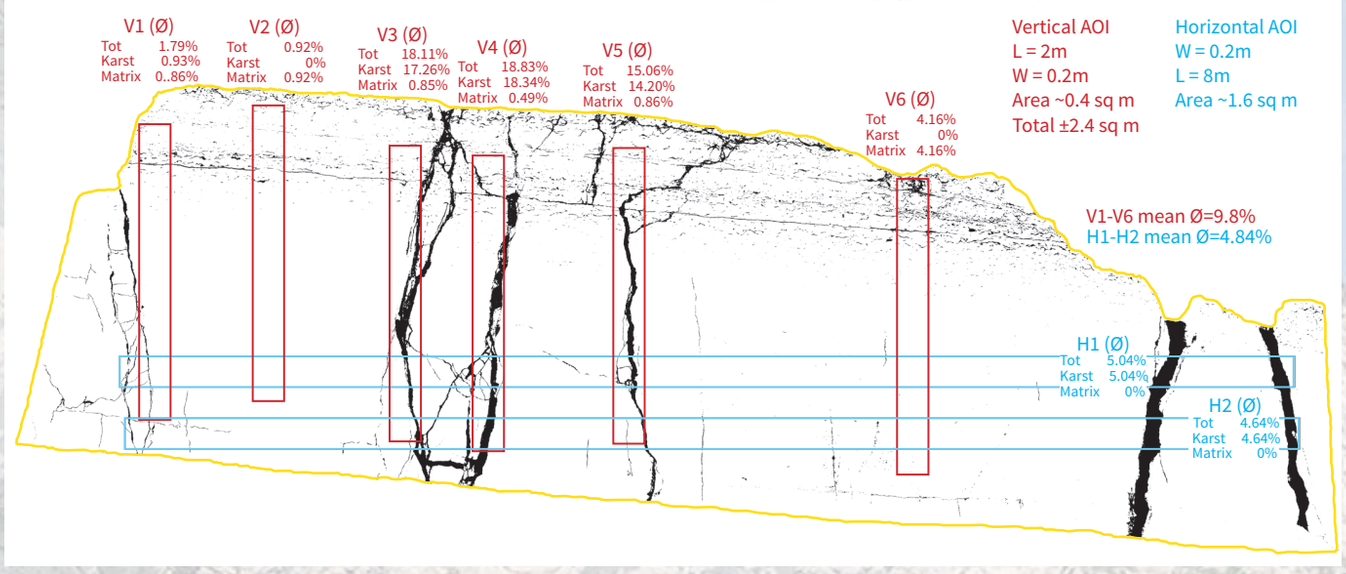
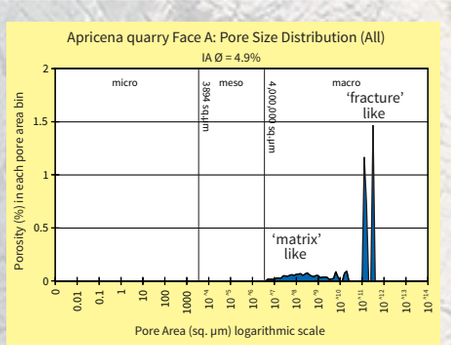
In this case matrix is “tight” (i.e. no microporosity but stylonodular pores present in discrete layers)

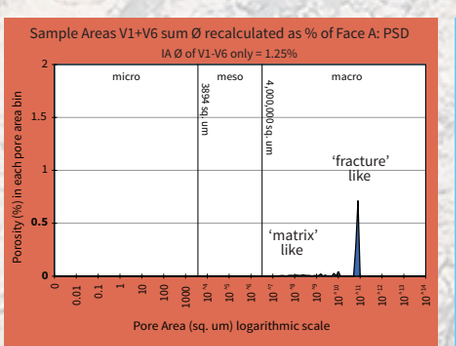




All AOIs underestimate actual fracture sizes due to clipping as each pseudo well is relatively small compared to the actual extent of the karstic fissures in the face.

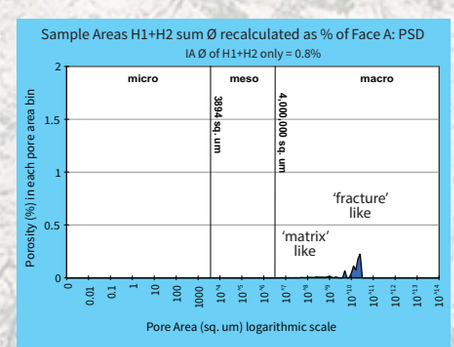
Additionally the mean porosity of all vertical pseudo wells is 9.8%, an overestimate compared to the whole face porosity of 4.9%.

Conversely the porosity mean of all horizontal pseudo wells is 4.64% slightly less than the whole face porosity.



Vertical pseudo wells (AOIs V1 to V6) are haphazard at encountering sub-vertical karstic fissures e.g. V2 and V6 do not intercept any karstic fissures whereas the areas of V3 through to V5 are made up of a higher proportion of subvertical karstic fissures.

This is simply due to the random spacing and orientation of the fissures relative to the vertical pseudo-wells and may be thought of as straightforward sampling bias.



The horizontal pseudo wells (AOIs H1+H2) intercept all the major karst fissure groups. Horizontal orientation has a significant +ve effect on capturing sub-vertical fissure occurrence but a -ve effect on fissure area/extent recorded.

Use of just vertical or horizontal sample data in isolation misrepresents the total porosity population of the face.

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