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Linking Gas Geochemistry with Pressure Domains and Fraccability in Shale Gas

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Summary

The Ordovician shale of the St Lawrence Lowlands in Quebec is prospective for shale gas production and very thick. Whereas the prime target is the carbonate rich Utica shale, the overlying and very thick Lorraine shale has also been evaluated, be it to a lesser extent. Geochemistry data commonly helps define domains and trends that may not extend beyond these domains (Fig.1).

Recent Quebec geochemistry data from the St lawrence Lowlands has been studied together with hydraulic frac and reservoir pressure data from the same wells. The first phase of the study has been focusing exclusively on vertical wells and has delivered new insights with respect to pressure domains and frac gradients.

The initial shut-in pressures measured during the hydraulic frac jobs have been studied per well and per area in the light of other information of a geochemical nature (percentage of methane, ethane, propane, wetness and carbon isotopes). A remarkable match has been revealed between three parameters (wetness/C1 content, isotope reversal and ISIP trends per well). Our analysis indicates that the traditional pressure gradient calculation could be challenged because some of the harder and easier rocks to frac have very similar gradients (Fig.3) and reservoir pressure gradients are also not in line with our regional understanding (Fig.4).

An isotope reversal takes place, for both Ethane (Fig.2) and Propane at a depth where Rock-Eval data starts to be unreliable due to suppression of the S2 peak. That depth is also where the ISIP (Initial Shut-In Pressures) trends per well intersect the lithostatic gradient (Fig. 5) and is related to the limit between a naturally pressured domain and an overpressured domain located below it. Our study indicates that this overpressure/isotope reversal depth could be used to calculate with acceptable precision the reservoir pressure at any depth within the overpressure domain (Fig 5).

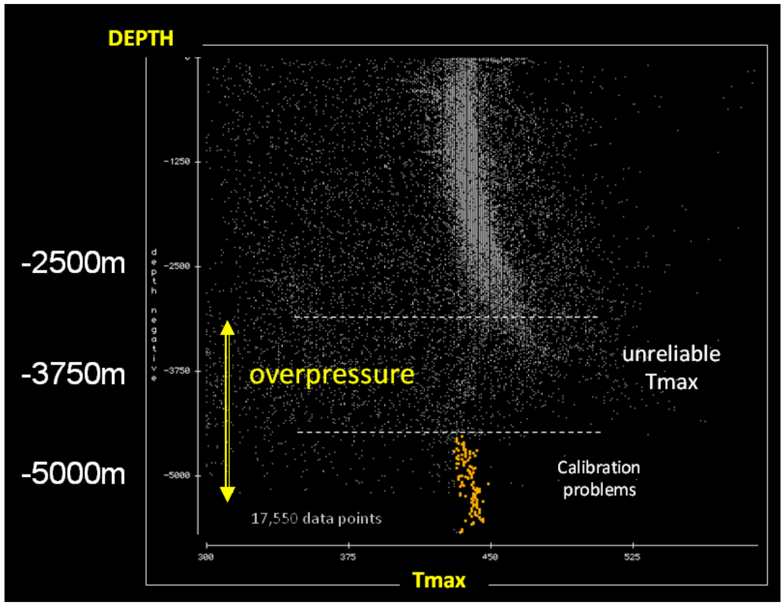

Fig.1 Tmax versus depth plot showing separate domains of reliability (Alberta data)

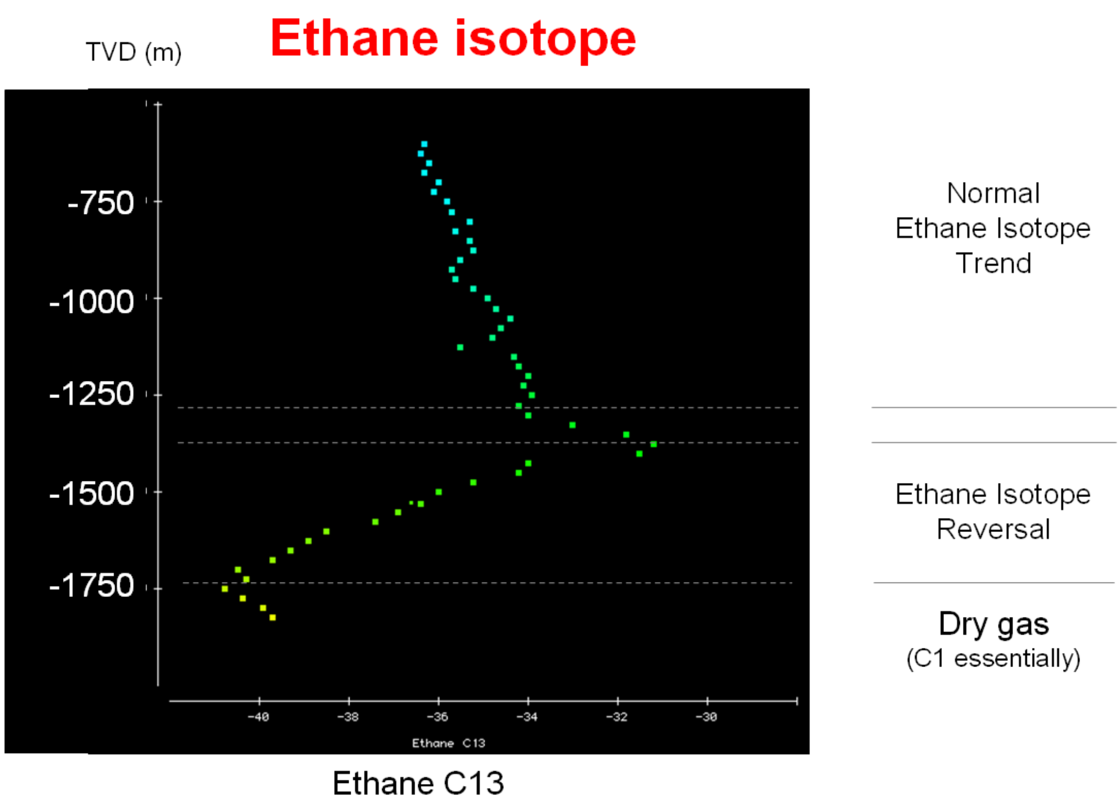

Fig. 2 Ethane isotope reversal in one well of Quebec

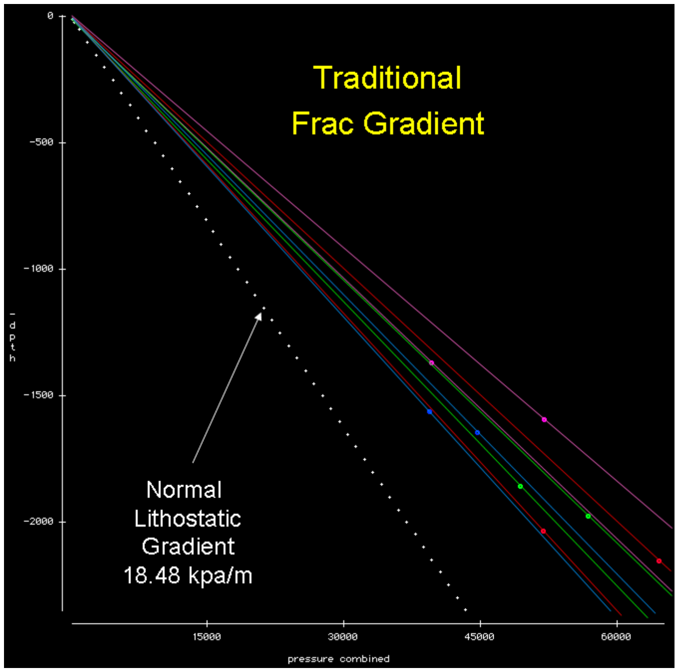

Fig.3 Traditional frac gradient estimation using Initial Shut in Pressures

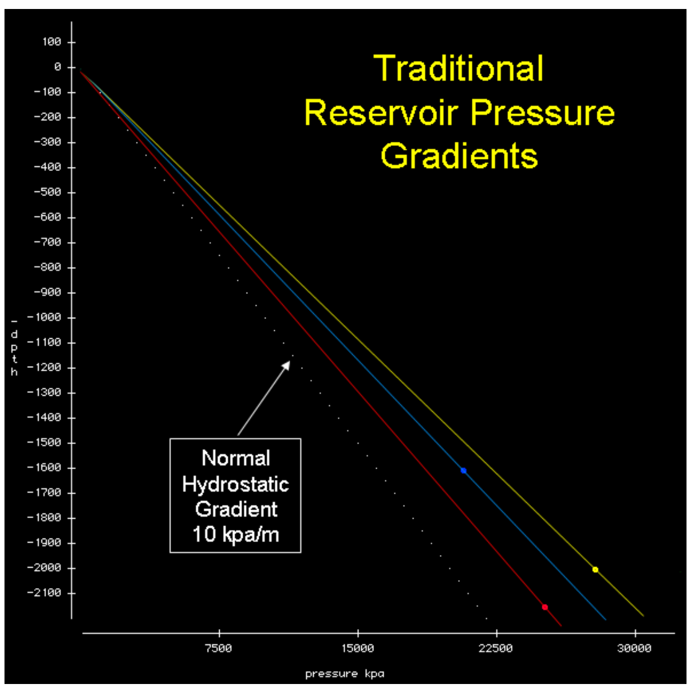

Fig. 4 Traditional Reservoir Pressure gradient from long term down-hole monitoring

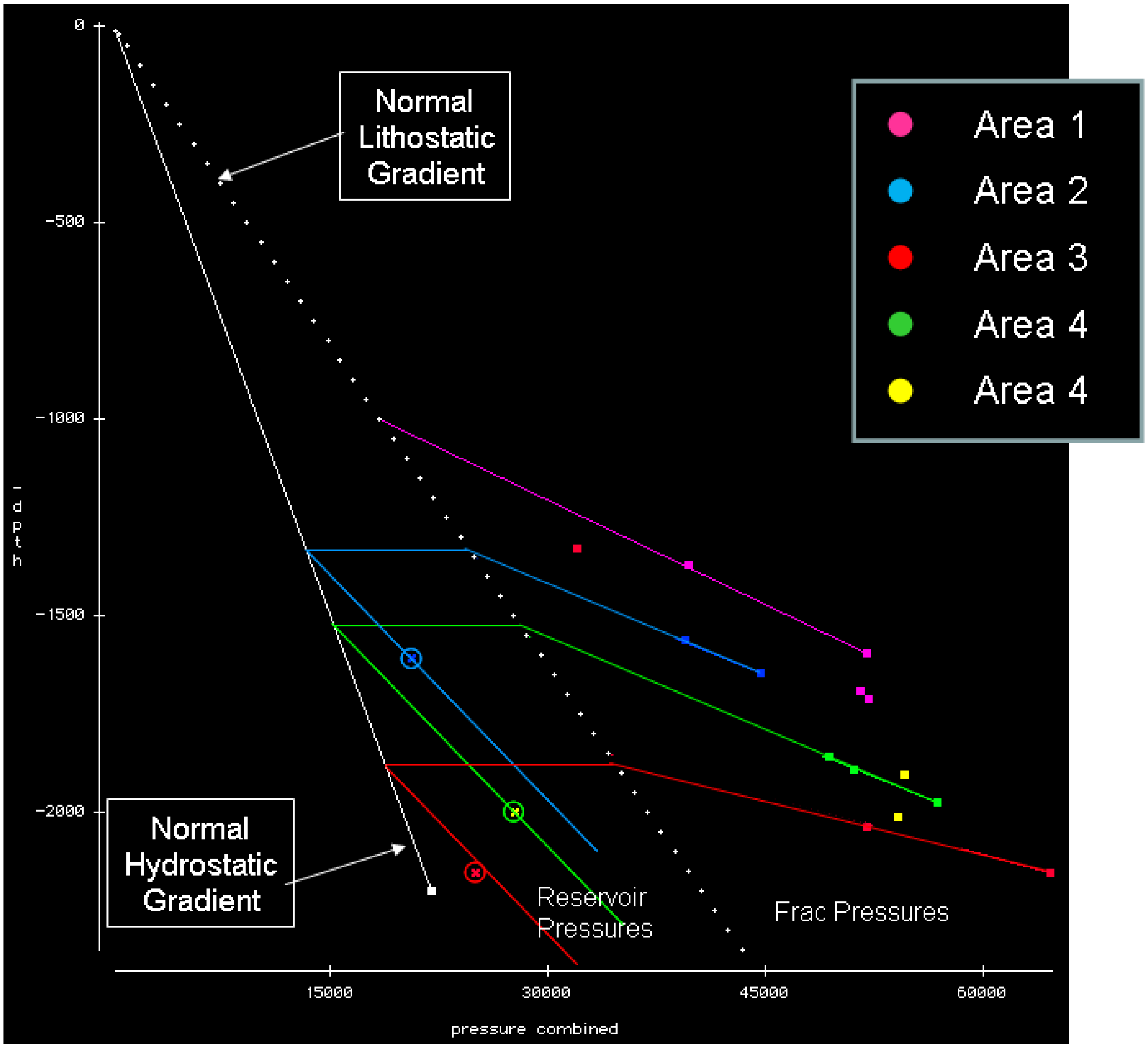

Fig.5 Newly defined gradients and link between reservoir pressures and frac gradients
Note that the depths expressed by the horizontal lines correspond to the upper limit of the overpressure domain which also correspond to the isotope reversal domain