Estimation of subsurface horizontal stress for semi- or half-consolidated sediments

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The horizontal stress is important for logging, constructing subsurface storage spaces and calculating normal stress on fault surface, however it is difficult to measure the horizontal stress directly in soft-sediments. Therefore, some theoretical and/or experimental methods have been needed for estimating horizontal stress. A relationships between horizontals stress and vertical stress was proposed for one of calculating module for Faultap, which is a software to evaluate fault seal capability, that have been developed in Japan National Oil Corporation since 1997.

Theoretically, Caquot(1934) has already proposed a basical idea to explain the relationship between angle of internal friction and angle of each grain friction(qm). Based on his considerations, sh=SA*tan(qm)/2, The qm is larger than 0, smaller than pi/2, where SA is area of any grain contacting point set, so that introducing Scv,Ks=C*SA*tan(qm),qm, where Scv is grain contacting area per unit volume. Because SA is related with number of contacting point, that is related with 3D porosity. However, this equation is also difficult for applying because of unknown parameter Scv and qm. To simplify this equation, we introduced two assumptions. It is that a relationship between 2D porosity(S%) and 3D porosity(F) can be described as S%=C%*F^x, where constant x that is defined by each sediment, where C% is constant. Another one is that solid part of sediments(inv_s%) also can be described as (inv_S%)=C%inv*(1-F)^y, using power y and inverse of S%, where C%inv is constant. We can get the function about Scv=CN{1-F0+ Cc* Log(sV/sV0)}^y, where the CN and Cc are constant. sV0 is initial stress for convenience 3D porosity F0. Thus, the variable of subsurface stress can be described as Ks = {Ks0+ Ck0 *Log(sV/sV0)}^y, where Ks0=(1-F0){CG*tan(qm)}^(1/y), Ck= Cc{CG*tan(qm)}}^(1/y). Using this equation, how fault induced micro structures that can be observed in outcrop are able to explain will be discussed.

References

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