STABILITY OF HIGHLY DEVIATED BOREHOLES IN GEOTHERMAL FIELD

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As the number of drill holes penetrated from the same site has been increasing recently, it has been demanded that the opportunities to complete higher deviated wells. Increasing of the inclination of the well could lead us to the various troubles such as enlargement of borehole, drillpipe stacking, poor cutting transport and so on, while drilling. Because the excessive inclination of the well causes the borehole collapse, the evaluation for the stability of the well must be important. The borehole failure can be estimated by the computed stress field around the borehole, using the liner elastic and isotropic model for the subsurface formation suggested by Aadnoy and Chenevent(1987) and the assumption of the in-situ stresses.

When a well is drilled, the rock surrounding the hole must take the load received that was previously taken by the removed rock. As a result, an increase in stress around the borehole, a stress concentration, is produced. If the rock is not strong enough, the borehole will fail.

It is reported that the major factor causing the wellbore collapse is the failure which is related by the shear effects rather than the tensiles, and that when the wellbore is fractured, tensile is the major factor causing wellbore failure.(Aadnoy and Chenevent, 1987). So at first we consider about the shear effects around the borehole using the equation of Von Mises Yield Condition. And then we consider about the tensile failure around the borehole.

We assumed that the in-situ stresses causing the fracture of the borehole are principal and directed horizontally and vertically. The two horizontal in-situ stresses are assumed the same value because of the lack of the information for subsurface formation. We can predict the relationship between the stress field and the well deviation theoretically using the linear elastic and isotropic model for plane-stress. We will discuss about the collapse observed in the Fushime geothermal field comparing with the theoretical models.

we obtain normal stresses in rectangular, σ_x, σ_y, σ_{zz} are as follows

$$\sigma_x = (\sigma_{T1} \cos^2\phi + \sigma_{T2} \sin^2\phi) \cos^2\gamma + \sigma_o \sin^2\gamma$$

$$\sigma_y = (\sigma_{T1} \sin^2\phi + \sigma_{T2} \cos^2\phi)$$

$$\sigma_{zz} = (\sigma_{T1} \cos^2\phi + \sigma_{T2} \sin^2\phi) \sin^2\gamma + \sigma_o \cos^2\gamma$$

$$\tau_{yz} = 0.5 (\sigma_{T2} - \sigma_{T1}) \sin(2\phi) \sin\gamma$$

$$\tau_{xz} = 0.5 (\sigma_{T1} \cos^2\phi + \sigma_{T2} \sin^2\phi - \sigma_o) \sin(2\gamma)$$

$$\tau_{xy} = 0.5 (\sigma_{T2} - \sigma_{T1}) \sin(2\phi) \cos^2\gamma$$

and normal stresses in cylindrical coordinates, σ_r, σ_θ, σ_z are

$$\sigma_r = P_w$$

$$\sigma_\theta = (\sigma_x + \sigma_y - P_w) - 2(\sigma_x - \sigma_y)\cos 2\theta - 4\tau_{xy} \sin 2\theta$$

$$\sigma_z = \sigma_{zz} - 2\nu(\sigma_x - \sigma_y)\cos 2\theta - 4\mu\tau_{xy} \sin 2\theta$$

$$\tau_{r\theta} = \tau_{rz} = 0$$

$$\tau_{\theta z} = 2(-\tau_{xz} \sin\theta + \tau_{yz} \cos\theta)$$

principal stresses, σ_1, σ_2, σ_3 are

$$\sigma_1 = \sigma_r = P_w$$

$$\sigma_{2,3} = 1/2\,(\sigma_\theta + \sigma_z) \pm 1/2\,[(\sigma_\theta - \sigma_z)^2 + 4(\tau_{\theta z})^2]^{1/2}$$

where, Pw = wellbore pressure, ϕ = borehole azimuth angle from x axis, θ = angular position around borehole, γ =borehole division from vertical, σ_o = overburden stress,