SUBSIDENCE AND HORIZONTAL MOVEMENT MAPS FOR APPLICATION OF RESERVOIR CHARACTERIZATION

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Normally, the inverse problem to map reservoir compaction from surface subsidence is an ill-conditioned system since the subsidence bowl gradually changes its curvature as shown in Fig.1a, hence, the boundary of pressure depleted area cannot be clearly identified from subsidence bowl. However, the analysis in this paper shows that the peak of lateral surface movement approximately coincides with the pressure depleted peripheral as shown in Fig.1b so that if both subsidence and lateral movement maps are constructed, the approximate shape of the pressure depleted area and the lateral distribution of reservoir compaction can be identified. These two maps may be used as it is as a diagnosis tool to identify the location of sealed fault, extent of reservoir section and non-recovered hydrocarbon section.

Imaging the reservoir compaction is further improved if a proper inverse method is applied with the subsidence and surface displacement maps as input data. This paper suggests, for inverse problems with real field conditions where reservoir compaction and elastic moduli are both unknown, to lump multiple layers into a few layers with equivalent anisotropic Young's modulus and to inversely calculate the reservoir compaction and the lumped anisotropic elastic moduli. The resolution and fluctuation of seek parameters are effectively adjusted by the Potter's error covariance off-diagonal elements. Fig.2a shows an inversion result without smoothening and Fig.2a shows an inversion result with smoothening with Potter's error covariance off-diagonal elements. The inverted compaction map shows, more clearly than the original surface displacement maps, the location of sealed fault, extent of reservoir section and non-recovered hydrocarbon section even for relatively deep reservoirs.

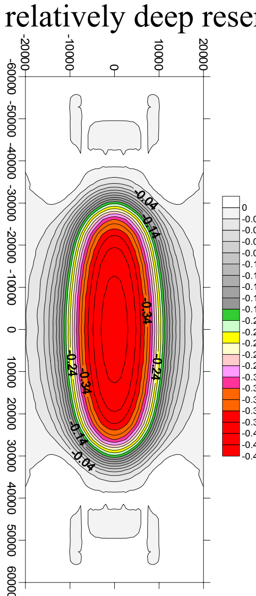

Fig.1a Subsidence data used for pressure inversion
Uniform pressure depletion=-1kpsi, Depth=5,000ft, A=10,000 ft, B=30,000ft, Er=200kpsi, Poisson ratio=0.2, Heterogeneous reservoir (Young's modulus alternates E1=1500kpsi and E2=750kpsi from top layer)

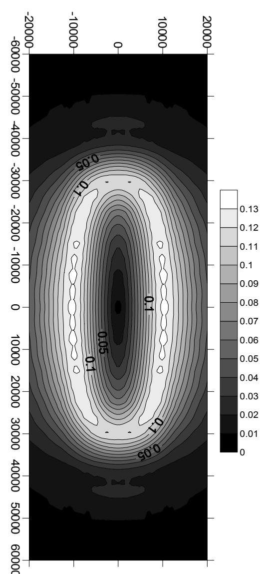

Fig1b Earth lateral displacement data used for pressure inversion, reservoir condition given in Fig.1a

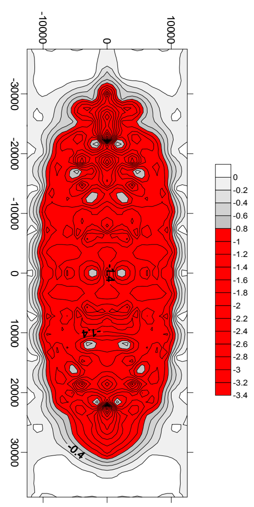

Fig.2a Reservoir pressure depletion inversion from surface subsidence and lateral movements shown in Figs.1a and b, no smoothening, (385 observation points=385x3 data, 341 pressure nodes in the above rectangular area), The initial pressure depletion estimate =0kpsi, initial Young's modulus estimate for the confining formation =1kpsi

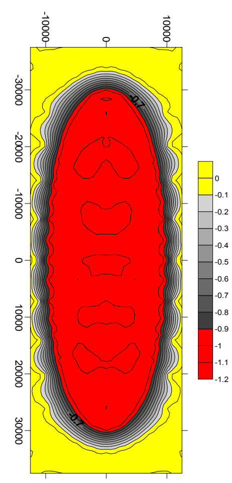

Fig.2b Reservoir pressure depletion inversion from surface subsidence and lateral movements by Figs.1a and b. With smoothening, (385 observation points=385x3 data, 341 pressure nodes in the above rectangular area)