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Extension of Godavari Gondwana sediments underneath Trap covered region of Satpura basin as evidenced from seismic studies in Deccan Syneclise, India

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ABSTRACT

We present a shallow P-wave velocity structure of the eastern part of Deccan Syneclise, central India, from the refraction and wide-angle reflection data recorded along two ~100 km long seismic refraction profiles in east–west (E–W) and north–south (N–S) directions using travel time inversion method. In addition to the P-wave velocity model, we have derived S-wave velocity model and estimated Vp/Vs and Poisson's ratios along the east–west profile. Travel time analysis and inversion of the data revealed three layers above the basement. The first layer with a P-wave velocity of 1.4–1.5 km s^{-1} represents alluvium and the thickness of this layer is varying between 100–400 m in the E–W and 30–100 m in the N–S profile. The Deccan Trap thickness is observed to be varying between 850 and 1250 m constitutes the second layer. P-wave velocity of the Deccan Traps is 4.8–5.2 km s^{-1}. Amplitude decay and travel time skips in the first arrival refraction data in some of the record sections indicate the presence of a velocity inversion i.e. low velocity zone (LVZ) beneath the Traps. Wide-angle reflection phases from top and bottom of the LVZ (top of basement) together with basement refraction phase are identified and modeled to derive LVZ thickness. The LVZ has been interpreted to be the Gondwana sediments sandwiched between Deccan Traps and basement. These sediments are about 200–450 m thick with a P-wave velocity of 3.6 km s^{-1}. The basement lies at about 1.60 km depth near Khandala in the west and Rajola in the north shows an upward trend towards south–east. The P-wave velocity of the basement is about 6.0–6.2 km s^{-1}. The inferred subtrappean sediments could be the possible extension of Gondwana sediments of the Godavari graben towards the Satpura basin.

1. Introduction

Deccan Syneclise is an intracratonic sedimentary basin covering an area of ~273 × 10^3 sq. km in western and central India (Vishnu Vardhan et al., 2008). The basin is mostly covered by Deccan Traps. Outcrops of Mesozoic and Gondwana sediments are present (Figs. 1 and 2) in western and eastern parts of Deccan Syneclise respectively (Kaila, 1988; Kaila et al., 1981, 1985; Mall et al., 2002). Significant amount of these sediments is reported to be hidden underneath the Deccan volcanic rocks (Traps) (NGRI, 1998, 2004; Sain et al., 2002; Mall et al., 2002). Oil industry has been engaged in exploring Trap covered regions for geologic and tectonic studies and hydrocarbon potential. Structural imaging in Trap covered regions has been a complex problem. Conventional seismic reflection method has not been successful because of the poor signal to noise (S/N) ratio in the near vertical range. Large impedance contrasts within the volcanics caused by interbeds, breccia and vesicles contaminate the primary reflections of interest with multiples, and scattered noise in this range (Sain et al., 2002; Pujol et al., 1989; Jarchow et al., 1994). Subtrappean sediments form a low velocity zone (LVZ) in seismic exploration due to the fact that a Trap layer with high seismic velocity is underlain by sediments with lower seismic velocity. Seismic refraction studies with large energy sources can provide high amplitude reflections from subtrappean interfaces at wide-angle range where the noise is less prominent (Jarchow et al., 1994; Sain and Kaila, 1996). Also in certain favorable geological conditions where a high velocity Trap layer underlain by low velocity sediments indicate amplitude decay and skip in the refracted first arrival times and their magnitude is a function of relative thickness of the two layers (Tewari et al., 1995). Amplitude decay and time skips in the refraction phases and wide-angle reflections from top of LVZ and basement are indicative of a seismic signature to the low velocity sediments hidden below the high velocity volcanic rocks.

Deep Seismic Sounding (DSS) studies in the Cambay-Narmada–Tapti region (Kaila et al., 1981; Sridhar and Tewari, 2001) indicate presence of subtrappean Mesozoic sediments in the form of grabens separated by a horst. Similar studies in the eastern part of Deccan Syneclise (Fig. 2) (Kaila, 1986; Mall et al., 2002) indicate presence of Gondwana sediments beneath the Traps. Integrated

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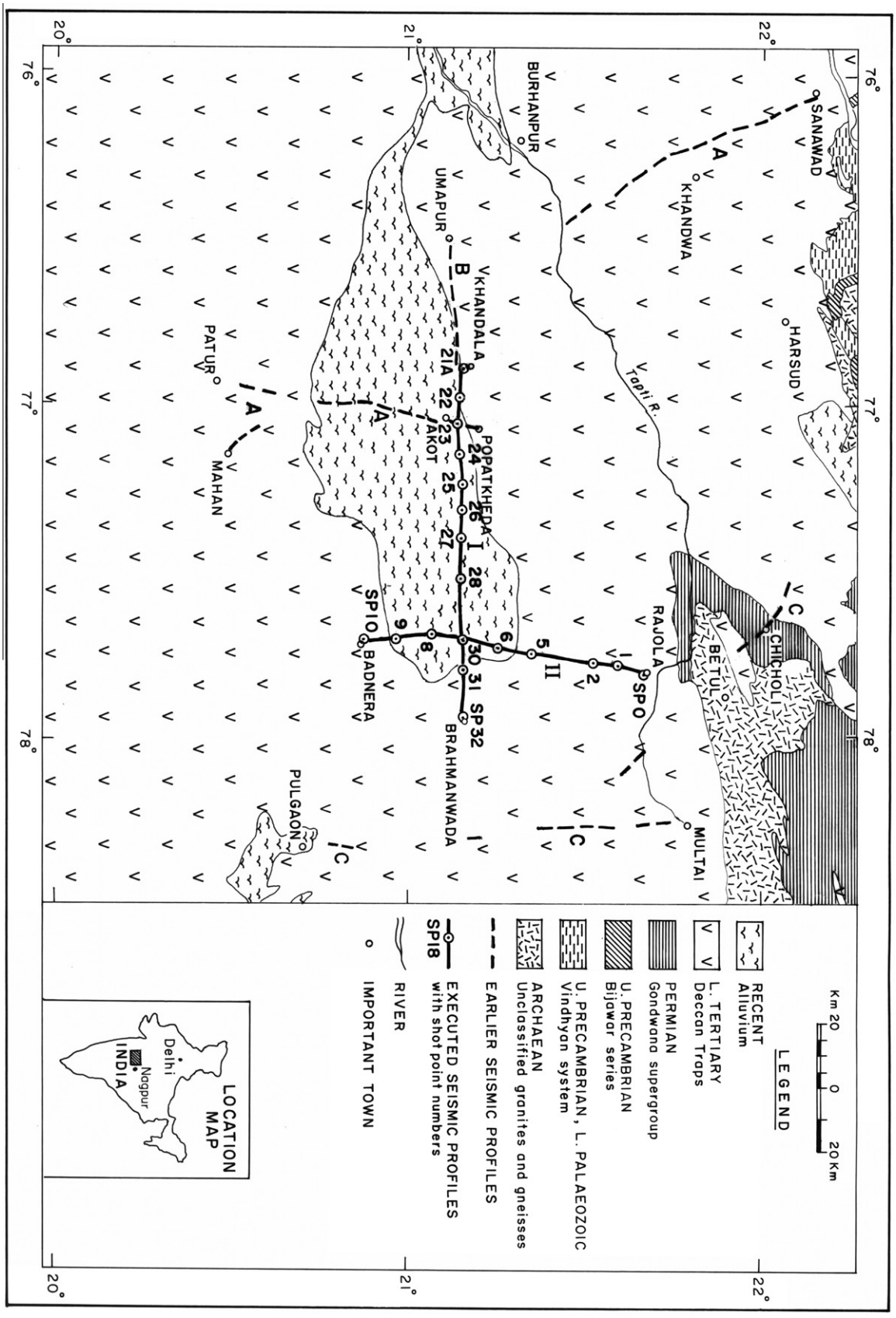

Fig. 1. Location of seismic refraction profiles along Khandala-Brahmanawada (E–W) profile I and Rajola-Badnera (N–S) profile II shown on geological map of the eastern part of Deccan Syneclise, central India.