The field examination of the Upper Devonian Tsil’ma and Ust’-Chirka formations cropping out in the middle reaches of the Tsil’ma River in the middle Timan region in 2008 and 2010 yielded first finds of buried soils (Shumilov and Mingalev, 2009; Shumilov, 2010). Paleopedogenic horizons in red rocks are most variegated. One of the specific morphological features of paleosoils is the occurrence of in situ root systems of terrestrial vegetation (Retallack, 1990; Aref’ev and Naugol’nykh, 1998; Yakimenko et al., 2000). In most examined paleosoil profiles, organic matter of roots is either decomposed or located more than 15 cm beneath their roofs (former daylight surfaces). Instead, former root systems represent branching channels filled with incoherent ferruginous ocher or small brownish yellow calcite crystals. During the geological evolution of sedimentary sequences including lithification, diagenesis, catagenesis, and metamorphism, the superposed processes eliminate or mask many features of fossil soils. Such transformations are primarily typical of organic matter (Alekseeva et al., 2009). This provides grounds for the formulation of an empirical rule: the older the fossil soil, the lower the share of organic matter preserved therein. For example, the loss of organic carbon in Quaternary paleosoils in a few hundreds of years after their burial may be as high as 70% (Demkin et al., 2007). In addition, accumulation environments of red rocks are very unfavorable for the preservation of organic remains, which are usually completely oxidized (Frolov, 1992). In this connection, issue of the preservation of such old in situ root systems in similar outcrops but different paleosoil profiles is of significant interest.

Analysis of the published data revealed that factors governing the preservation of organic matter of root systems in paleosoils were practically ignored in the previous works. The present work is aimed at filling this gap in the knowledge for at least Devonian buried soils in the middle Timan region.

GEOLOGICAL REVIEW

The Tsil’ma area has been studied for more than five centuries: copper ores of the Timan cupriferous province are known at least since the reign of Tsar Ivan III who sent the first state geological-prospecting expedition to the Tsil’ma area in 1491. In 1496, a large copper smeltery was launched near the Zavodskoi Creek flowing into the Tsil’ma River 8 km upstream of the Rudyanka River (Karamzin, 1991; Shumilov, 2008). Nevertheless, the geological structure of this area remains poorly investigated. Geological organizations carried out survey in this region in the terminal 1960s. Scientific investigations were episodic and unsystematic.

The Tsil’ma River basin in the middle Timan region is characterized by wide development of terrigenous rocks belonging to the lower and middle substages of the Upper Devonian Frasnian Stage. The lower substage comprises the Yaran (Yaran Formation), Dzh’er (Listvennichnaya and Valsa formations), and Timan (Tsil’ma and Ust’-Chirka formations) horizons. The upper Frasnian substage corresponds to the Sargaevo (Ust’-Yareg Formation) and Domanik (Kraipol Formation) horizons (Fig. 1). It should be noted that some researchers attribute rocks of the lower Frasnian Substage to the Middle Devonian (Tsyganko, 2006).
At the current stage of investigation, paleosoil profiles are reliably defined only in rocks of the Tsil’ma and Ust’-Chirka formations that are overlain with stratigraphic (locally, angular) unconformity by shallow-water marine sediments of the Sargaevo Horizon composed of alternating fine-grained silt sandstones, clayey silts, and silty (largely gray-blue) clays. Rocks of the Tsil’ma and Ust’-Chirka formations are variegated and mostly represented in different proportions by alternating clayey, silty, and sandy varieties ranging from slightly silty clays to almost pure sandstones. The rocks are mainly greenish gray, green, bluish green, and, rarely, gray. As a whole, their section consists of many elementary cyclites with the lower sandy and upper clayey parts. Thickness of cyclites varies from 0.5 to 5 m. The sand content increases upward the section. It should, however, be noted that structural—textural properties of rocks in individual beds are highly variable along the strike, and their thickness also show a wide variation range. Virtually all rocks contain a variable admixture of basic volcanogenic material up to the point of the formation of individual beds and lenses of dark gray tuffites and tuffs.

The sequence is characterized by relatively high concentrations of coalified plant remains ranging from the fine dispersion of detritus to the so-called wood dumps in sandstones with fragments of individual trunks up to 25 cm across and 3 m long. Less common are lenses up to 5 cm thick and 15 m long. It should be noted that some large plant remains are buried obliquely relative to bedding (Fig. 2), indirectly suggesting a spasmodic (catastrophic) influx of detrital material to the sedimentation basin.

The outcrops exhibit many leveling surfaces with box-shaped incisions, which were likely formed by wandering flows. Such channels are usually filled by pebbles (up to 10 cm across) of underlying rocks, occasional quartz pebbles, fragments of Devonian fish carapaces, and abundant large plant remains oriented along channels. Higher in the section, they are overlain by sandstones with large-scale cross-bedding. The channels are up to 50 m wide and 3 m deep. Usually