PROVINCES OF THE MARINE BOREAL UPPER TRIASSIC

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ABSTRACT

Marine Upper Triassic rocks of the Boreal realm occur along the coasts and on islands of the Arctic Ocean. They consist of mostly terrigenous dark colored sediments with relatively monotonous paleofaunas. Seven provinces are distinguished. Some data about transgressions and regressions in the Upper Triassic succession are also presented.

Marine Upper Triassic rocks of the Boreal realm occur along the coasts and on islands of the Arctic Ocean from Spitsbergen Archipelago and Bear Island through north central and east Siberia, northern Alaska and Yukon to the Canadian Arctic Archipelago. There are two offshoots southward: in eastern Asia down to Japan and Transbaikalica; and in the western North American plate down to British Columbia (Fig. 1).

The Late Triassic Fauna of the Boreal realm is relatively monotonous and is much poorer taxonomically than the Tethyan realm. There are many common endemic Boreal species, rare endemic genera, and very rare endemic Boreal families.

Predominantly terrigenous dark colored deposits accumulated in the Boreal basin, representing passive continental margin sediments. In North-Eastern Russia, in Chukotka and on the northern Okhotsk sea coast, there are many volcaniclastics and pyroclastics among the Upper Triassic, especially Norian-Rhaetian, terrigenous rocks. They represent sediments of volcanic island arc systems situated between the eastern Siberian continental block and the ancient Pacific Ocean (pre-Pacific). The thickness of the Upper Triassic Boreal rocks fluctuates greatly - from several tens of meters to 4 km - and is 1 to 2 km in many areas.

Seven provinces are distinguished in the Boreal realm on the basis of the type and completeness of succession, lithological peculiarities, and presence of endemic or tethyan elements among fauna. These include the Yakutian, Anyui, Far East, North Alaskan, Liard, Ellesmerian, and Spitsbergen provinces (Fig. 1).

The vast Yakutian province is characterized by the most complete succession of the Upper Triassic marine terrigenous rocks (Fig. 2). These are represented by shallow water, outer neritic, and basin facies. Characteristic endemic species among brachiopods and mollusks, and lack of tethyan species are also typical. Carnian and early Norian ammonoids and bivalves are common but not diverse, being represented mainly by Trachyceratidae and Halobiidae. Bivalves and brachiopods prevailed in the middle and late Norian and Rhaetian. Hiatuses are rare and short. Non-marine sediments occur in the north western part of this province only. In the south eastern part of this province, near a boundary with the Anyui province, upper Norian and Rhaetian volcaniclastic rocks and rare intermediate and mafic tuffs are present. The thickness of the Upper Triassic rocks is usually 1 to 2 km and increases in some areas up to 3.5 km; in the Omolon Massif it decreases to 300 m and less (Dagys et al., 1979; Decision, 1978).

In the Anyui Province some Tethyan species and genera of bivalves and ammonoids (cassianelids, haloritids, and choristoceratids) are known among prevailing boreal Norian paleobiota (Afitsky, 1970; Bychkov, 1992). Large amounts of volcaniclastics and pyroclastics occur in all Upper Triassic succession. There are tuffites, intermediate and mafic tuffs, basalt, andesite, and dacite flows (Afitsky, Lychagin, 1987). Disconformities and unconformities are present in this province. Norian and Rhaetian rocks occur in many areas, and the Carnian section is fragmentary or are absent. The mainly shallow water Upper Triassic rocks usually lie directly on top of the Upper Palaeozoic section (Bychkov, Soloviev, 1992). The thickness of the Upper Triassic volcanic - terrigenous rocks is 500 to 2500 m (Fig. 3).

The Upper Triassic in the Spitsbergen province is represented by marine deep-water and shallow-water neritic terrigenous facies during Carnian and early to middle Norian, whereas the middle to upper Norian and Rhaetian sediments are non-marine or absent. The thickness of the section is 100 to 2000 m (Fig. 2). Some Carnian and early Norian Boreal province biotas are common here (Korchinskaya, 1982; Preobrazhenskaya et al., 1985).

Limestones, calcareous mudstones, siltstones and sandstones prevaile often among Upper Triassic sediments in the North Alaskan province, occuring in large amounts (Fig. 3). Tethyan genera and species of ammonoids (tropitids) are present among Carnian fauna; Boreal and Pacific species and genera of bivalves (Monotidae) are also known (Silberling, 1970; Grant-Mackie and Silberling, 1990). The thickness of the Upper Triassic rocks is small (40 to 200 m) (Dettermann et al., 1975).

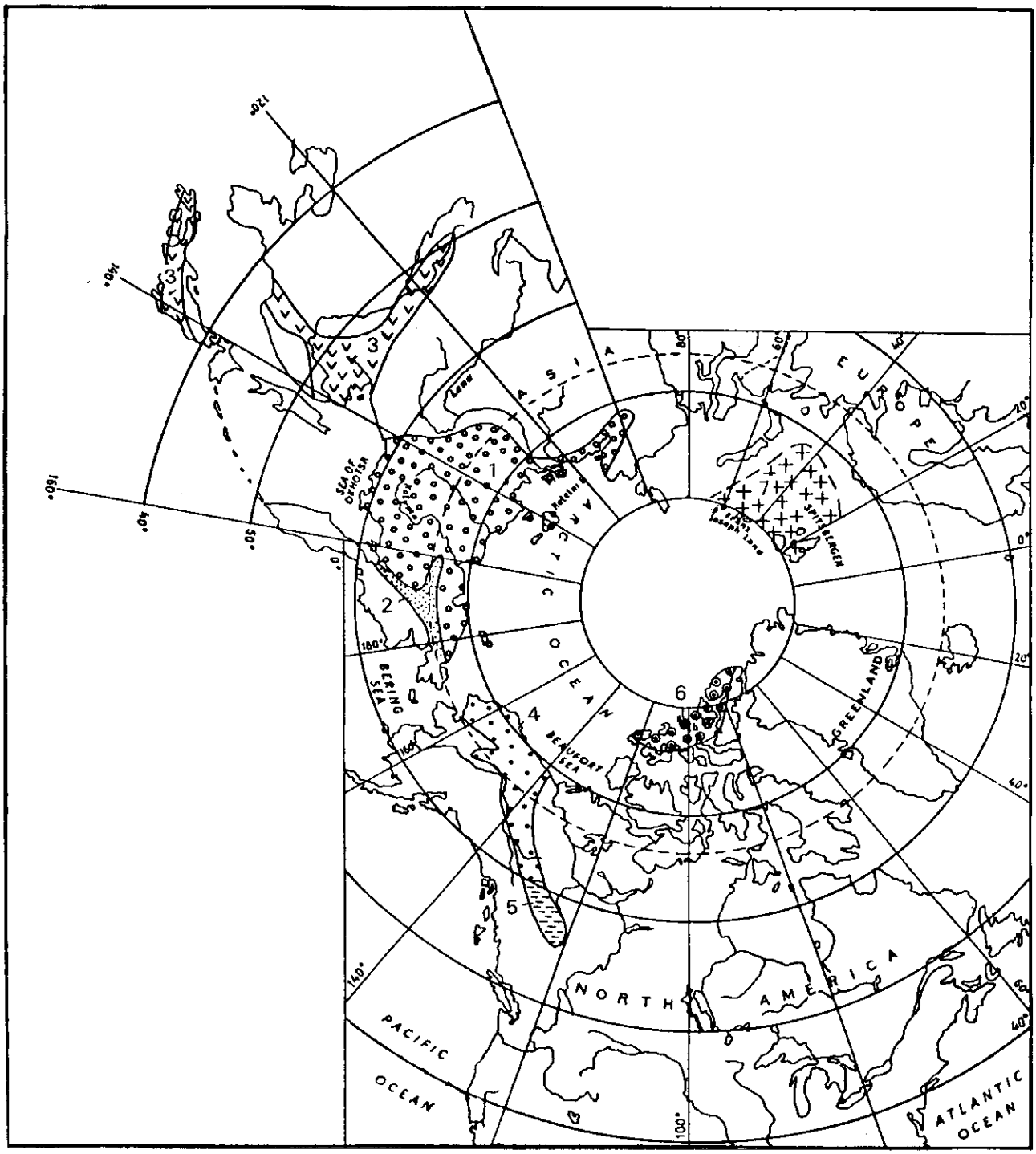

Fig.1. Map showing known and probable extent of marine Boreal Upper Triassic Provinces: 1 - Yakutian; 2 - Anyui; 3 - Far East; 4 - North Alaskan; 5 - Liard; 6 - Ellesmerian; 7 - Spitsbergen.

The Upper Triassic Pardonet Formation of the Liard province occurs in north eastern British Columbia near the Tethyan realm boundary. It consists mainly of limestones, calcareous siltstones, and shelly limestones. Thickness of the formation is up to 200 m (McLearn,1960; Douglas, 1976). Tethyan genera and species prevail among ammonoids and bivalves. In contrast,there are rare Boreal genera and species of ammonoids in the early Norian, and Boreal species of monotids in the late Norian. Accordingly, E.T.Tozer (1982) considers this province as a middle paleolatitude province.

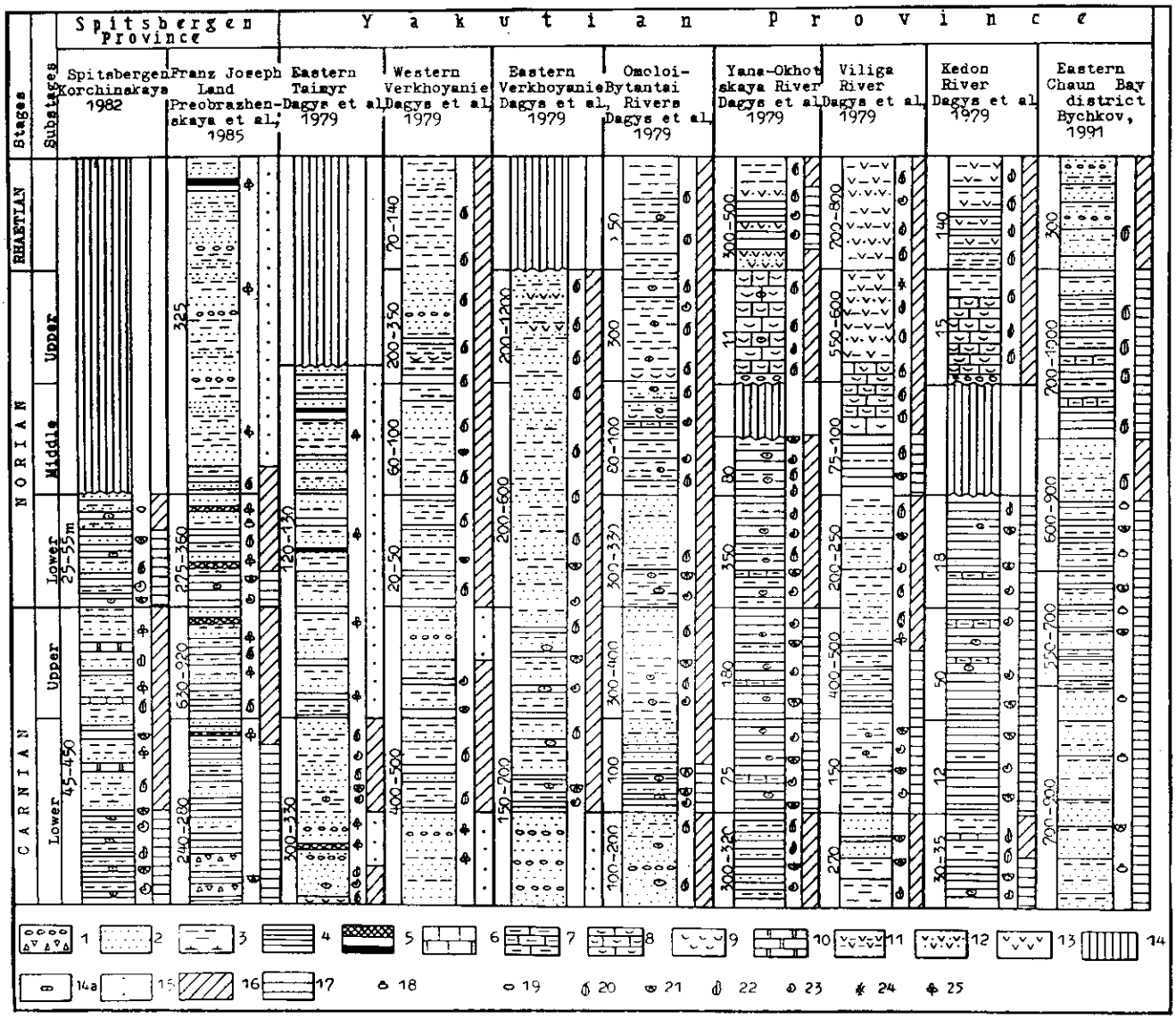

Fig.2. Correlation scheme of the Upper Triassic in the Spitsbergen and Yakutian Provinces.
Lithology: 1 - Conglomerate and breccia; 2 - Sandstone; 3 - Siltstone and calcareous siltstone; 4 - Argillite, shale; 5 - Coaly argillite and coal; 6 - Limestone; 7 - Clayey limestone; 8 - Coquina-limestone; 9 - Coquina; 10 - Dolomite; 11 - Tuffite; 12 - Tuffaceous sandstone, tuffite, intermediate tuff; 13 - Andesite; 14 - Hiatus; 14 a - Nodule. *Environments*: 15 - Lagoonal and continental; 16 - Shallow-water; 17 - Deep-water; *Faunas*: 18 - Foraminifers; 19 - Conchostracs; 20 - Benthic bivalves; 21 - Pelagic bivalves; 22 - Brachiopods; 23 - Ammonoids; 24 - Bryozoans; 25 - Fossil plants.

The Upper Triassic rocks of the Ellesmerian province in the Sverdrup basin are predominantly terrigenous, but in some areas there are many calcareous siltstones (Tozer, 1961). The Carnian is represented by shallow-water and rare outer neritic facies. The Norian is represented by nonmarine rocks with separate horizons of marine shallow-water siltstones and sandstones. The fauna is poor and of Boreal type, and Tozer (1982) refers this province to a high paleolatitude province. Rare Tethyan elements (tropitids) of the Carnian ammonite fauna are also present. The thickness of these rocks fluctuates widely, ranging from 80 m up to 3 - 4 km.

The marine Upper Triassic sections of the Far East province consist of terrigenous, mainly shallow water sediments. It usually begins with transgressive Norian beds overlying a disconformity or unconformity on top of older Middle and Lower Triassic or Paleozoic rocks (Decision, 1982; Masao et al., 1965). Carnian continental deposits are sometime present. Some sections are represented by upper Norian or middle to upper Norian rocks only. The paleobiota is Boreal and dominated by bivalves with rare remains of ammonoids. Tethyan bivalve

genera (cassianelids) also occur, but are rare (Okuneva, 1992). The thickness of the Upper Triassic section here varies 400 to 4000 m (Fig. 4).

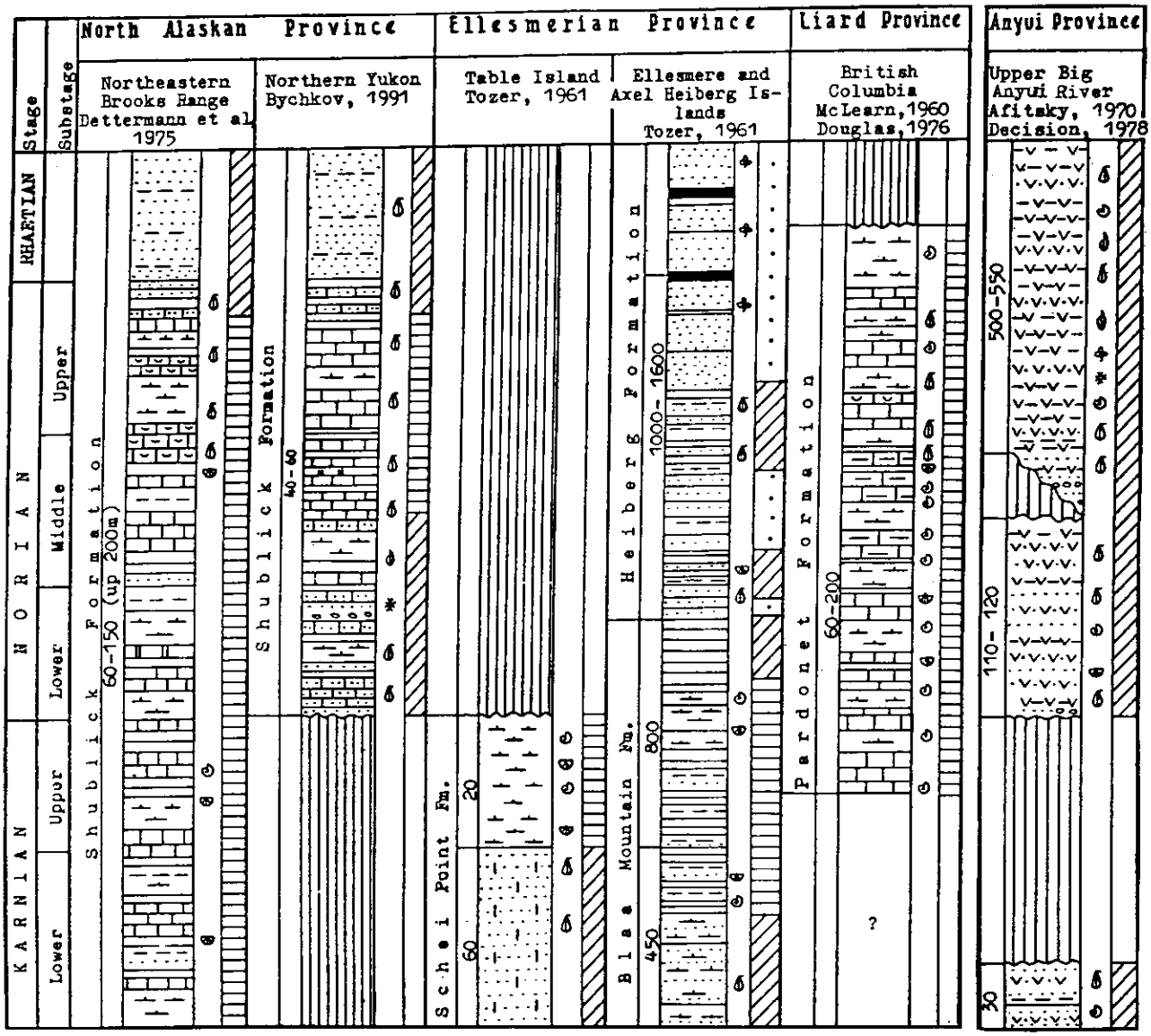

Fig.3. Correlation scheme of the Upper Triassic in North Alaskan, Ellesmerian, Liard, and Anyui Provices
See legend in fig. 2.

The transgressions, regressions and transgressive-regressive cycles in the Upper Triassic succession of the Boreal realm are briefly reviewed below; an accompanying graphic summary for most of the regional stratigraphic sections is also shown in Fig. 5.

A pronounced transgression occurs in the Yakutian province during the early Carnian. The basal strata of this transgressive-regressive (T-R) cycle usually contain bivalves and ammonoids assigned to the *Neoprotrachyceras seimkanense* Zone of the late early Carnian age (Bychkov, Polubotko, 1973). At places this transgression occur lower in the section, in the early early Carnian (at the base of the *"Protrachyceras" omkutchanicum* Zone), but it never happens on the level of the Ladinian-Carnian boundary. The environment of this horizon is similar througout the Yakutian province. A transgression in the Sverdrup Basin, Ellesmere province, and in the Franz Joseph Land, Spitsbergen province, which Embry (1988) and Mork (Mork et al., 1989) dated as earliest Carnian age, probably has early or late early Carnian age. More biostratigraphic control is required for accurate age dating

of the cycle. The cycle that was initiated in the early Carnian in the Yakutian province lasted until the earliest Norian. There is yet another T-R cycle in the Ellesmere province in the late Carnian age, after Embry (1988).

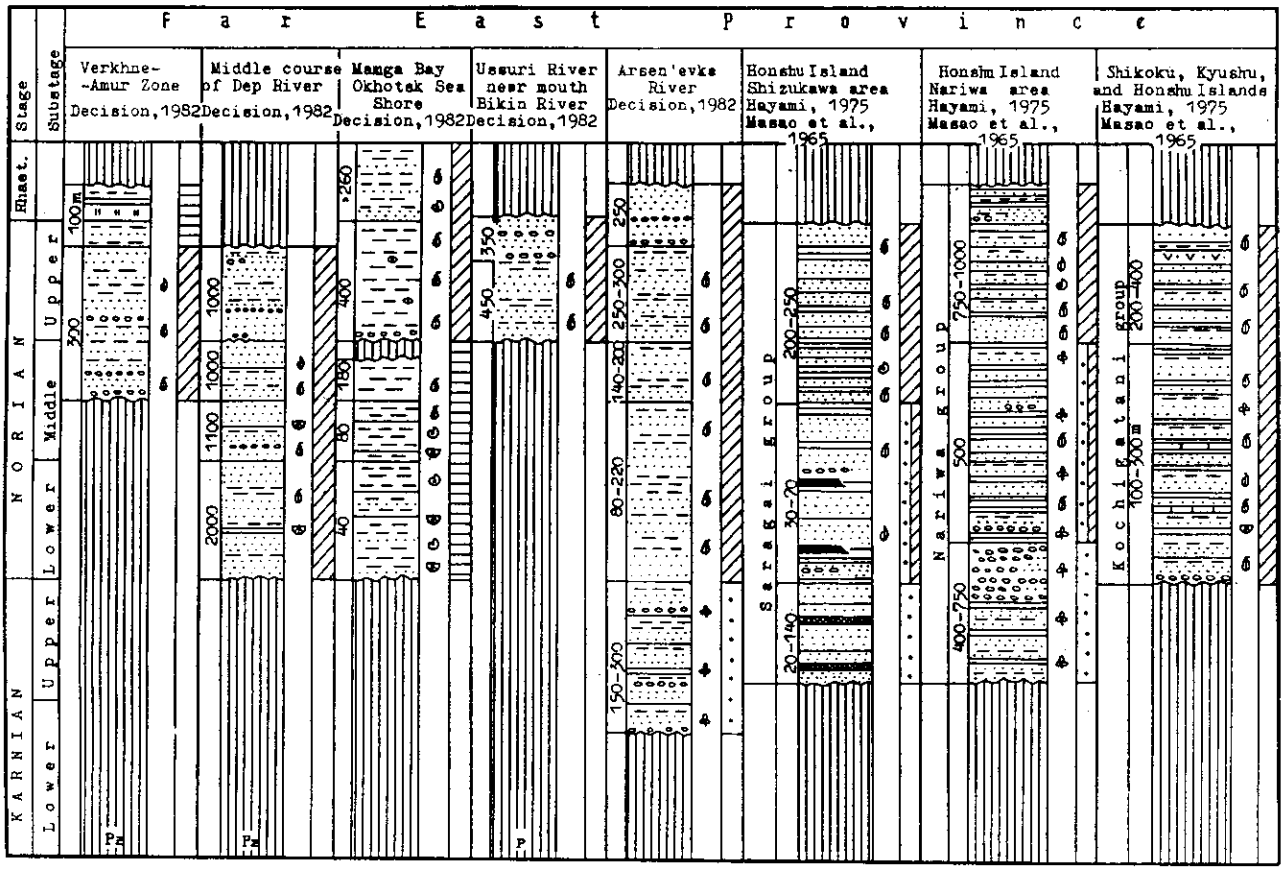

Fig.4. Correlation scheme of the Upper Triassic in the Far East Province
See legend in fig. 2.

A basal Norian transgression is recognized in many provinces. The basal strata of this cycle contain earliest Norian bivalves and ammonoids. In the Far East province a long regression in the Carnian preceeded the transgression. This area was land during Carnian and at times during the preceding Middle and Early Triassic also. In the Okhotsk area of the Yakutian province, and in the northern Yukon area of the North Alaskan province, there was land during the Carnian, back into the Middle and Early Triassic, and locally during the Late Paleozoic as well. In other areas of the Yakutian province, marine basins deepened at the Carnian-Norian boundary and there is transgression in many places; however, the environment didn't change during this time at some places in the central portion of the basin. Embry (1988) described the basal Norian transgression in the Sverdrup Basin of the Ellesmere province. This T-R cycle lasted until early middle or latest middle Norian in many areas of the Yakutian and Ellesmerian provinces.

The next transgression, which is very pronounced in many areas of the Yakutian and Far East provinces, began in middle middle Norian or earliest late Norian age. This transgression could be named as the monotid sea transgression. The upper middle Norian or upper Norian rocks often transgressively overlie Lower to Middle Triassic or Paleozoic deposits in Chukotka, Transbaikalica, the Far East, and Japan. Embry (1988) records transgression in the late middle Norian in the Sverdrup Basin. This T-R cycle lasted until the Triassic-Jurassic boundary in most places, but in some areas of the Yakutian and Far East provinces there is also a transgression at the Norian-Rhaetian boundary.

A transgression of the earliest Jurassic age is documented in many areas of the Yakutian province. Embry (1988) and Mork (Mork et al.,1989) described it in the Sverdrup Basin and in the Svalbard. Locally, however, the upper middle Norian-Rhaetian cycle persisted into the Hettangian and Sinemurian.

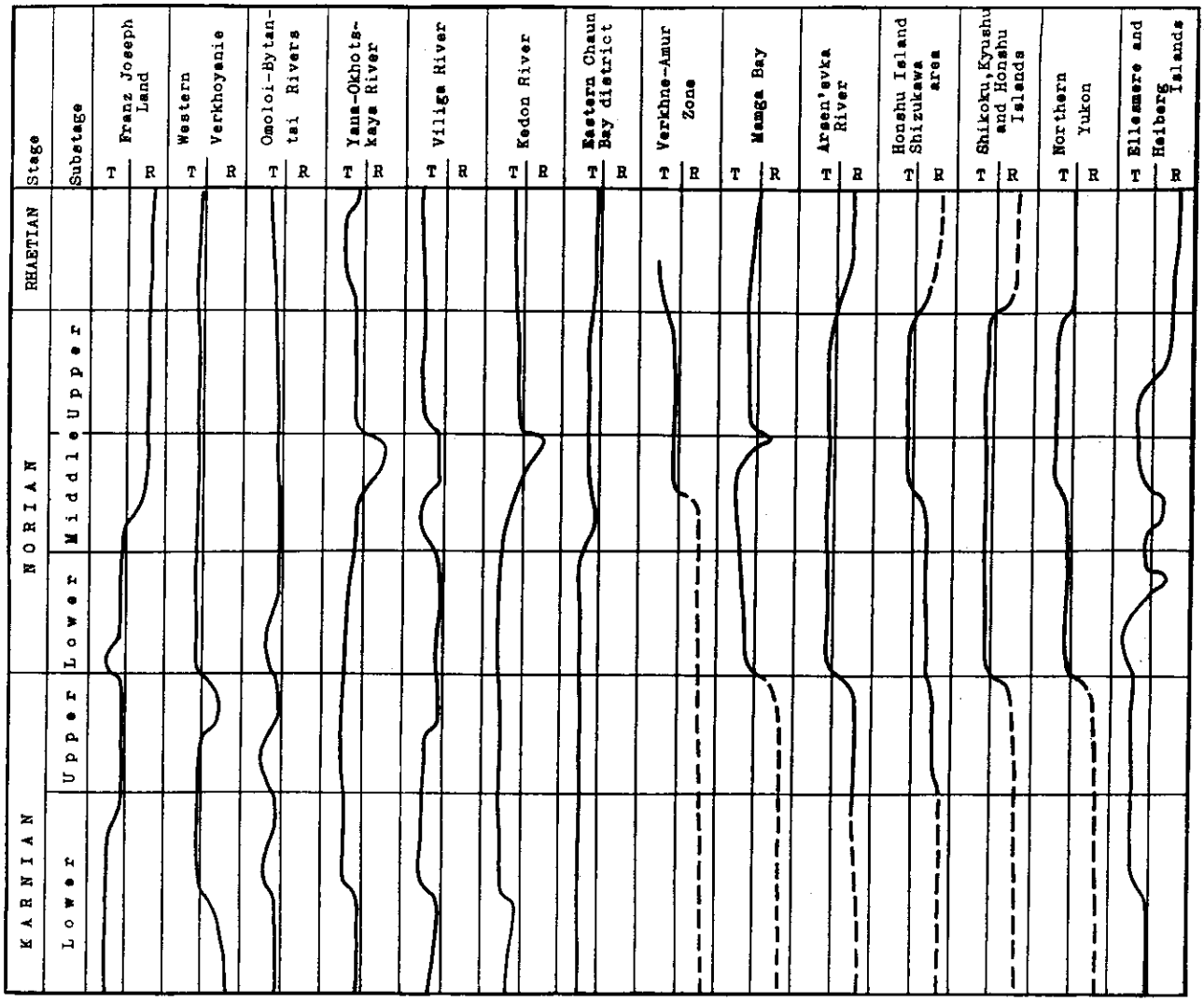

Fig. 5. Boreal Upper Triassic transgressive - regressive curves

Thus, the Upper Triassic succession in the Yakutian province consists usually of 3 transgressive-regressive cycles dated as middle early Carnian to late Carnian, early to middle Norian, and late Norian to Rhaetian; a fourth cycle (Rhaetian) may be recognized locally. Embry (1988) recognized 4 cycles in the Sverdrup basin of the Ellesmere province; Mork (Mork et al., 1989) recognized 3 cycles in the Svalbard basin. In the Norian succession of the Far East province there seems to have been 1 cycle.

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