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# Introduction to the volume, and definition and use of the term 'tectono-sedimentary element'

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**Abstract**

*The present volume is rooted in a map of sedimentary successions of the Arctic Region by Grantz et al. (2011), and contains a brief, but comprehensive compilation of geological and geophysical data characterizing all significant sedimentary successions in the Arctic, which cover 57% of the polar area north of 64°N. Two main goals have been designated: (i) to provide, based on the present-day knowledge and data, a characterization of all Arctic sedimentary successions (or sedimentary accumulations), and (ii) to supply a snapshot of hydrocarbon-related exploration in the Arctic at the end of the second decade of this millennium. To achieve these goals, we represent sedimentary successions as consisting of one or several "Tectono-Sedimentary Elements" (TSE). This concept allows delineation, mapping, and characterization of 9 categories of TSEs based of main tectonic regimes that formed accommodation space.*

*A TSE characterization template has been developed as an efficient method of organising and presenting the most important information about stratigraphy, structure, and petroleum geology of a TSE, including most significant exploration facts. This organizational*

*architecture is the backbone of the volume and is a key feature that distinguishes it from other similar works about the sedimentary basins.*

The Arctic Ocean and surrounding continental shelves host sedimentary successions of tremendous size and volume that preserve the geological record of past 1.6 Ga of the Earth history. The total area of sedimentary accumulations is *c.* 15,310,000 km$^2$, which is *c.* 57 % of the entire Arctic area north of 64°N (Fig. 1). These accumulations bear potentially huge hydrocarbon resources (Gautier et al. 2009), including biogenic methane and gas hydrates. Combined with the rapidly degrading permafrost, the last two also represent significant source of greenhouse gases.

Since the collapse of the Soviet Union, the geoscience community has witnessed a sharp increase in Arctic research owing to the implementation of national and international programs in the Earth sciences (see **Drachev et al. (b)**[1]). Many pre-2010 results were published in GSL Memoir 35 (Spencer et al. 2011), which represents the latest and the most significant collection of Circum-Arctic research papers. Also notable is the widely cited 2008 Circum-Arctic Resource Appraisal, which produced the first geologically based petroleum assessments in the public domain for 30 Arctic basins (Gautier et al, 2009; Moore and Gautier, 2017). Since that time, the Arctic has gone through a peak of exploration related to both the petroleum industry and United Nations Convention on the Law of the Sea (UNCLOS), which generated a wealth of new geological and geophysical data. In the past 5-6 years, Arctic exploration activities have greatly diminished due to unfavourable global petroleum market conditions driven by oversupply of oil that has further declined amid the COVID pandemic and climate concerns.

**What is this volume about?**

[1] Text references in bold type and lacking year of publication refer to papers in the present volume.

This volume is rooted in a map of sedimentary successions of the Arctic region by Grantz et al. (2009 and 2011). Their approach in mapping and classification of the sedimentary successions has been adopted, with some modifications, for the purpose of this volume. Two main goals have been designated: (i) to provide, based on the present-day knowledge and data, a characterization of all Arctic sedimentary successions (or sedimentary accumulations), and (ii) to supply a snapshot of hydrocarbon-related exploration in the Arctic at the end of the second decade of this millennium. To achieve these goals, we characterize sedimentary successions as consisting of one or several “Tectono-Sedimentary Elements (TSE)”. This concept allows delineation, mapping, and characterization of first-order sedimentary bodies in sedimentary accumulations, but also forms a basis for their classification by tectonic affinity.



Furthermore, to be able to compile the wealth of geological and geophysical data in a brief but comprehensive and orderly manner, we have developed an organisational framework, called a TSE-characterization template (see below in this chapter), which forms a fixed framework in which contributors are able to capture all significant facts in descriptive chapters. This approach allows readers to navigate through chapters in the volume with relative ease and simplicity in a way that would not be possible without the template, while also providing opportunities to easily compare and contrast the various aspects of the sedimentary accumulations vertically and across the Arctic region.

**Definition and use of Tectono-Sedimentary Element**

Characterization of all Arctic sedimentary successions represents a huge challenge considering their geological diversity. Sedimentary accumulations are known to occur within a wide range of tectonic elements, such as basins, ridges, horsts, platforms, troughs, rifts etc., and not all these elements can be classified as concave-down depressions or basins. Therefore, a more neutral term is needed, one that would allow individual first-order sedimentary bodies of any configuration to be distinguished and mapped. For the purpose of this work, we developed the term “Tectono-Sedimentary Element” (TSE), which is defined as follows: *a TSE is a first-order undeformed or moderately deformed, unconformity-bounded sedimentary succession that shares common lithostratigraphy and, therefore, geological history and confined to accommodation space that formed in a particular tectonic regime (i.e. a tectonic element or a group of elements).* A TSE, therefore, corresponds to a distinct tectono-stratigraphic cycle and is closely related to Sloss’s “sequence” (Sloss 1988).

Terms “tectonostratigraphic sequence”, and “tectonostratigraphic unit”, which are widely used in the literature (e.g., Olsen 1997; Zhi-qiang et al. 2010), are close analogues of the term “tectono-sedimentary element”. However, we decided not to use these terms to avoid connotation with: (i) a tectonostratigraphic terrane, another commonly used term for describing internal architecture of fold belts, and (ii) a depositional sequence, which is a more definite, in terms of sequence stratigraphy, sedimentary body.

Sedimentary successions that underwent penetrative deformation and metamorphism within fold and thrust belts or belonging to crystalline basement of Archaean and Proterozoic cratons are not included in TSEs. It is impossible to assign a precise criterion to define “moderate deformation”. Generally, we limit the degree of deformation to that which would allow hydrocarbon systems to exist, i.e., not preventing maturation, migration, trapping and preservation of hydrocarbons. Intensely deformed and exhumed fold belts of the Arctic are discussed in a separate chapter by **Drachev et al.(a)** and in the accompanying Enclosure D.

In this volume, we recognize the following main categories of TSEs based on tectonic settings during deposition of corresponding sediments:

1. Prograded continental margin TSE (present-day margins only),
2. Oceanic basin TSE (present-day oceans only),
3. Syn-rift TSE,
4. Continental platform TSE (including stable continental shelf, or shelf terrace, deposits),
5. Passive continental margin TSE (ancient margins only),
6. Continental sag basin TSE
7. Foreland basin (Synorogenic) TSE,
8. Orogenic collapse TSE,
9. Strike-slip basin TSE

*Prograded Continental Margin TSEs* include post-breakup sedimentary successions of the present-day Norwegian-Greenland, Eurasian, Canadian, and Baffin Bay passive continental margins. These TSEs are extensive in their area, totaling c. 3,932,000 km$^2$, or 26 % of all Arctic sedimentary accumulations. Accommodation space for this TSE category formed by thermal subsidence and sediment load, similarly to other rift-related settings. But these successions are unique in their sedimentary architecture, which is dominated by large clinoforms of siliciclastic sediments that prograded from adjacent continents (Fig. 2).

However, it needs to be noted that this term should not be applied in its sequence stratigraphy *sensu stricto*, because the post-rift sedimentary wedges of passive margins also include aggradational and retrogradational successions.

The prograded margins TSEs include the entire post-rift section from the basal rift-cessation unconformity and analog stratigraphic surfaces to the sea bottom. They are mostly underlain by the stretched and thinned continental crust and syn-rift and pre-rifts sedimentary accumulations, while their distal parts could downlap onto exhumed mantle and/or oceanic crust. They are distinguished by their age, which reflects the timing of breakup events and onset of the spreading in the Arctic region in the Mesozoic and Cenozoic. The prograded margins flanking the Canada Basin merge laterally and do not have natural internal boundaries. For the lack of supporting stratigraphic or tectonic subdivisions, we have set arbitrary boundaries using physiographic and political features. The prograded margin TSEs are characterized by **Fyhn (b)**, **Faleide et al. (a,b,e)**, **Skaryatin et al. (b)**, **Houseknecht (b)**, **Embry et al. (b)**, and **Knutz et al**.

*Oceanic basin TSEs* include post-breakup sedimentary successions of modern oceanic basins where underlain by oceanic crust (Fig. 2). These accumulations occur in the deep-water settings distant from the prograded margins in the Norwegian-Greenland, Eurasian, Makarov-Podvodnikov, Canada, and Baffin Bay basins. Accordingly, these TSEs are mostly composed of deep-water turbidite and debris-flow and related sediments, contourites, and other pelagic facies. In Baffin Bay, due to its narrowness, pelagic facies of its deepest axial part interfinger with distal facies of prograded margins successions and, thus, the oceanic basin TSE is not mapped individually. The central Norway-Greenland Basin oceanic deposits are not included in the volume due to their insignificant (<1 km) thickness (Straume et al.

2019). The oceanic basin TSEs are characterized in chapters by **Faleide et al. (e)**, **Hutchinson et al.**, and **Knutz et al**.

*Syn-rift TSEs* are sedimentary successions accumulated in the accommodation space formed in extensional tectonic settings. They are key elements for zones of intercontinental rifting and/or transtensional deformation. They are commonly represented by syn-tectonic wedge-shaped fault growth sedimentary packages and corresponding seismic reflectors within half-grabens, grabens, and tilted blocks. This is the main element of rifted continental margins that underlie prograded continental margin TSEs (Fig. 2) as described by **Fyhn (a)**, **Fyhn and Hopper**, **Fyhn et al. (a,b)**, **Faleide et al. (d,e)**, **Tsikalas et al. (b)**, **Bunkholt et al.**, **Houseknecht (a)**, **Embry et al. (a)**, **Planke et al.**, and **Gregersen et al.** Because rifting is the most effective process for crustal thinning and development of the accommodation space, this TSE category is present in almost every major continental basin, such as Arctic Alaska (Hanna Trough; **Houseknecht (a)**), Timan-Pechora (Pechora–Kolva Rift; **Prishchepa et al. (a)**), Western and Central Barents Sea (Hammerfest Basin, Nordkapp Basin, Bjørnøya Basin; **Henriksen et al.**, **Dore et al.** and **Ryseth et al.**, respectively), or West Siberia (Koltogor-Urengoy Rift; **Deev et al. (b)**), The syn-rift TSEs contain heterogeneous lithologies, including siliciclastic, carbonate, volcaniclastic and igneous rocks, and range in age from Meso- and Neoproterozoic to Cenozoic. Deposition of syn-rift TSE strata and associated rifting are currently taking place in the Laptev Rift System (Siberian Arctic), which is a continental segment of the divergent boundary between the N. American and Eurasian tectonic plates (**Drachev et al. (d)**).

*Continental platform and stable continental shelf successions* represent another distinct and widely occurring TSE category (Figs 2 and 3). Their accumulation is controlled by slow epeirogenic movements and sea-level fluctuations away from tectonically active zones, usually in internal parts of continents and on proximal passive continental margins (inner/mid shelf). They are composed of interbedded continental, transitional and shallow marine carbonate and siliciclastic sediments having low to flat regional dip and low to moderate thicknesses typically varying from several hundred metres to a few kilometres. Often these successions are found to underlie syn-rift successions and are described as *pre-rift* TSEs. In other cases, they cap post-rift sag deposits reflecting cessation of the rapid thermal subsidence of rift-related basins. Continental platform TSEs are characterized by **Dewing and Hadlari**, **Dore et al.**, **Drachev and Ershova**, **Ershova et al.**, **Fallas et al. (b)**, **Frolov et al**., **Henriksen et al. (b)**, **Houseknecht (a)**, **Lavoie et. al.**, **Lundschien et al.**, **Morrow**, **Pinet et al.**, and **Prishchepa et al. (b)**. The "Syn-epeirogenic TSE" of **Morrow** is a synonym for this category. **Dore et al.**, and **Prishchepa et al. (b)** also use the term "Intracratonic TSE" as a close synonym for this category.

*Passive margin TSEs* are often defined where they are thought to be deposited in a palaeo-passive continental margin setting, mostly along margins of the East European, Siberian and North American cratons. These TSEs are difficult to distinguish from continental platform and stable continental shelf deposits based on seismic data alone, and thus, some of the latter may be included in this TSE category. The related sedimentary successions vary significantly in their age and lithology, from Proterozoic to Mesozoic and from siliciclastic- to carbonate-rich. The typical examples of passive margin TSEs are: Mesoproterozoic siliciclastic successions of the northern Siberian Craton (**Deev et al. 2021a**, **Khudoley et al.**), Paleozoic carbonate and siliciclastic successions of the Timan Pechora Province and adjacent Korotaikha and Kusy-Rogov basins (**Prishchepa et al. (a)**,and **Sobornov (a,b)**), Upper

Paleozoic-Triassic siliciclastic strata of the East Barents Megatrough (**Drachev et al. (c)**), and the Lower Paleozoic carbonate succession of the Ogilvie Platform (**Morrow**). These TSEs can be of a significant thickness and include oceanward-prograding clinoforms and barrier riffs, which distinguish them from continental platform TSEs. For the Mezoproterozoic-Paleozoic successions developed along the northern margin of Siberian Craton, **Deev et. al. (a)** uses the term “Craton margin TSE”.

*Continental sag basin TSEs* are a distinct category of the Arctic sedimentary successions, although occurring on a limited scale. These successions fill accommodation space created by post-rift subsidence, which, in turn, is a function of the thermal anomaly and magnitude of the continental lithosphere thinning during a single or multiple rift events. These basins, which are also called ‘intracratonic sag basins” or “interior cratonic basins” (Leighton et al. 1990), and the associated sedimentary fill is also referred to as “post-rift” (Fig. 3). Although, to some extent resembling continental platform and stable continental shelf TSEs by their lithologies and depositional environments, they consist of significant thicknesses of sediments (often 5 to over 15 km thick) having been accumulated in a relatively short period of time. Rapid subsidence, uncompensated sediment accumulation, and confined geometries are characteristic of these basins and often result in anoxia and deposition of condensed organic-rich sediments. These TSEs dominate Sverdrup, West Siberia, South Kara, East Barents, and North Chukchi basins (**Embry et al. (c)**, **Deev et al. (b)**, **Drachev et al. (c,e)**, respectively).

*Foreland (Syn-orogenic) TSEs* are sedimentary successions deposited in foreland basins adjacent to the frontal part of fold and thrust belts, such as the Eagle and Cordilleran foreland basins in Northwest Canada, Queen Elizabeth Islands Basin in the Canadian Arctic

Archipelago, Korotaikha Basin in Pechora Sea, Yenisei-Khatanga and Verkhoyansk basins in the East Siberia (**Deev et al. (a), Dewing and Hadlari, Fallas et al. (a)**, **Lane et al.**, **Prokopiev and Drachev, Prokopiev et al.**, **Sobornov (a,b)**, respectively), as well as over broad parts of adjacent continents. Accommodation space for these TSEs have been created by the subsidence of a rigid continental crust under a load of tectonic thrust sheets or nappes transported from adjacent fold belts (Fig. 3). These TSEs are dominated by siliciclastic sediments and are often capped by coarse-grained shallow-marine to alluvial units (molasse). In some chapters, the "Syn-orogenic TSE" is used as a synonym for the "Foreland TSE". Foreland basins and neighboring continental basins are commonly affected to various degree of inversion caused by contractional deformation in the adjacent orogens (Fig. 3).

*Orogenic collapse TSEs* are sedimentary successions formed within fold belts in post-orogenic extensional/transtensional setting (Fig. 3). Here, we use the term "orogenic collapse" in a broad sense, not only as a gravity-driven mechanism of lowering orogens (e.g., Rey et al. 2001), but as various extensional (including strike-slip-related transtension) settings within orogens that result in the transition from crustal thickening to crustal thinning. These TSEs are typical in the interior parts of young fold belts as in the South Chukchi – Hope, and Anadyr basins (**Antipov et al.**, **Skaryatin et al.(?)**). This TSE category is also inferred by many researchers to occur at the base of the sedimentary fill of the Norwegian Barents Sea where it is assumed to be related to the collapse of the Scandinavian Caledonides in Late Devonian to Early Carboniferous (**Brunstad et al.**, **Dore et al.** and **Henriksen et al. (a)**). Upper Cambrian to Lower Ordovician siliciclastic syn-rift accumulations of the Timan-Pechora Province are also inferred to reflect the Timanian Orogen collapse

(**Prishchepa et al. (a)**). The Orogenic Collapse TSEs are dominated by various continental and transitional siliciclastic sediments of many hundred to several kilometres in thickness.

*Strike-slip basin TSEs* represent strike-slip-associated sedimentary depocentres developed in major zones of transcurrent deformation, such as the West Barents sheared continental margin (**Faleide et al. (c)**, **Ryseth et al.**), and in the Yukon Flats Basin in Central Alaska (**Stanley**). Their presence is also inferred in the South Chukchi Basin (**Skaryatin et al. (a)**). This category overlaps with the 'Syn-rift TSE" category because both commonly exhibit a mix of extensional and translational (*i.e.*, oblique) strain and fault displacements and overall geometry of the individual basins. This category includes sediments of "pull-apart basins" or "strike-slip basins' (e.g., Nilsen and Sylvester 1995).

*Pre-rift TSE and post-rift TSE* are the terms that are commonly used in the descriptive chapters of this volume. This terminology is mainly associated with intracontinental rifts, *e.g.*, the North Sea rifts (Ravnås et al. 2000) and passive continental margins (Falvey 1974). However, in this volume it is also applied to sedimentary successions of miscellaneous tectonic settings, where they either underlie or overlie syn-rift TSEs.

The most distinctive members of the post-rift category are prograded margin TSEs. Pre-rift accumulations in rifted continental margins commonly include continental platform TSEs (**Fyhn (b)**). The latter also overlie post-rift sedimentary fill in intracontinental basins (**Dore et al.**, **Ershova et al.**, **Prishchepa et al. (b)**) and rift-related sag basins (**Embry et al. (b)**, and **Houseknecht (a)**).

The mapping of TSEs in the rifted continental margins of the Norwegian-Greenland Sea requires a different approach (**Brekke et al.**). Successive rift events and short periods of post-rift sediment accumulation occurred frequently at these margins, lasting through a prolonged period of extension from the Early Devonian to the Early Eocene. The frequent interplay of these facies through time complicates subdivision of these successions into syn-rift and post-rift TSEs. For these conjugate margins, the main principle has been defining TSEs that clearly correlated between the two margins using major tectono-sedimentary breaks and related regional unconformities found in both margins.

**Composite Tectono-Sedimentary Elements**

The majority of Arctic sedimentary successions have evolved through multiple tectonic regimes through time and, therefore, consist of more than one TSE. Mapping and characterizing every individual TSE would represent a herculean task that could not be accomplished in a framework of a single volume. Therefore, we needed to combine some individual TSEs into larger sedimentary bodies, “Composite Tectono-Sedimentary Elements” (CTSEs). Areal and stratigraphic extents of resulting CTSEs correspond to the sedimentary successions mapped by Grantz et al. (2009 and 2011) with some modifications (see Enclosures A, C and E).

In the majority of cases, a CTSE represents a vertical stack of individual TSEs from top of consolidated (deformed and metamorphosed) basement to an upper bounding unconformity or the ground surface, as schematically illustrated in Figs 2 and 3. In some instances, TSEs are also laterally shingled (as in the Timan-Pechora, East Barents, and some other CTSEs). We name CTSEs by first-order tectonic element(-s) they are composed of, e.g., Ogilvie Platform CTSE, Trøndelag Platform and Halten–Dønna Terraces CTSE, or, in case when they combine several elements, by their geographic location, e.g., South-Central Barents Sea CTSE or North Kara CTSE. In this volume, CTSEs belonging to continental rifted margins are universally defined as including at least two individual TSEs, a pre-rift, and a syn-rift (Fig. 2). Pre-rift parts of these CTSEs end at the proximal limit of extensional deformation. If the pre-rift TSE continues onto the continent beyond the rifted margin, it is included in a CTSE mapped on the adjacent continent. For example, the pre-rift part of the Beaufortian CTSE along the rifted margin of the Canada Basin that includes Lower Ellesmerian strata becomes part of the Arctic Alaska platform CTSE on the continent outside of the Canada Basin rift shoulder.

Yet not every mapped succession represents a CTSE. There are 22 TSEs that have been mapped and described as stand-alone large sedimentary accumulations including 8 prograded margin TSEs, 4 continental platform TSEs, 5 foreland basin TSEs, 2 oceanic basin TSEs, and 2 orogenic collapse TSEs. An attempt to classify the defined sedimentary successions based on their plate-tectonic affinities is given in the final chapter of the volume (**Drachev et al. (f)**).

**About the template**

The TSE characterization template has been developed with one main purpose: to provide contributors with an efficient method of organising and presenting the most important information about stratigraphy, structure, and petroleum geology of a TSE, including most significant exploration facts. This organizational architecture is the backbone of the volume and is a key feature that distinguishes it from other similar works about the sedimentary basins (e.g., Coleman and Cahan 2012; Miall 2019).

The characterization template consists of 10 descriptive sections, as follows:

1. **Age**: This section provides a brief information about TSE stratigraphic age;

2. **Geographic location and dimensions**;

3. **Principal data sets**: This section includes two or three subsections: "*Wells*", "*Seismic Data*" and "*Outcrops*" (if applicable). Emphasis is made on datasets that provide key information about TSE regional geology and structure;

4. **Tectonic setting, boundaries, and main tectonic / erosional / depositional phases**: This section provides a synopsis of key facts about tectonic setting, structural relationship with adjacent elements and depositional history;

5. **Underlying and overlying rock assemblages**: This section furnishes age limits of TSE as constrained by ages of underlying and overlying rocks. Divided into two subsections: "*Age of underlying basement (consolidated crust), or youngest underlying sedimentary unit*", and "*Age of oldest overlying sedimentary unit*";

6. **Subdivision and internal structure**: This section provides characterization of smaller tectonic elements (for example, horsts and grabens in a TSE of extensional origin) including their dimensions, structural style, and age;

7. **Sedimentary fill**: The section contains information about TSE lithostratigraphy including regional stratigraphic and seismic-stratigraphic nomenclatures. It is organized in three subsections: "*Total thickness*", "*Lithostratigraphy/seismic stratigraphy*", and "*Depositional environment and provenance*". In some chapters, the latter two subsections are combined;

8. **Magmatism**: This section includes short summary of all magmatic rocks that are hosted by a TSE;

9. **Heat flow**: The section provides short overview of all heat flow data and the results of modelling;

10. **Petroleum geology**: The section represents a brief but comprehensive summary of all major facts related to the TSE petroleum geology organized in the following subsections: "*Discovered and potential petroleum resources*", "*Current exploration status*", and "*Hydrocarbon systems and plays*". The latter is further subdivided into subsections focused on important play elements, such as "*Source rocks*" (age, thickness, TOC, organic matter type and maturation), "*Reservoirs*" (age, thickness, composition, porosity, permeability of known and potential reservoir rocks), "*Seals*" (age, thickness), and "*Traps*" (type, size, formation time).

Each section and subsection of the template is illustrated by relevant maps, cross-sections and diagrams including maps showing geographic location, location of drilled wells and seismic profiles, sedimentary thickness, structure and tectonics, and location of exploration licenses and discovered hydrocarbon fields. Other illustrations include one or several cross-sections, maps of the organic matter maturity, location of the mapped leads and prospects, fragments of seismic profiles, and some other diagrams. Each chapter also includes a "Chart showing TSE lithostratigraphy, tectonic events and hydrocarbon play elements", which is constructed similarly across all descriptive chapters in the volume with an aim of presenting complex information about the TSEs in a consistent graphical summary format.

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## Figure Captions

**Figure 1.** Map showing areal extent of sedimentary successions (colourful polygons) in the Arctic that are characterised in the M57 volume. Descriptive chapters in the volume are organized in 5 sections as per the sectors shown in this map.

**Figure 2.** A schematic drawing illustrating tectono-sedimentary elements that are common in passive continental margin setting. In this volume, a passive continental margin is subdivided into a rifted margin and a prograded margin TSE. The former occupies stretched and thinned continental crust and is composed of pre-rift and syn-rift TSEs that together form a rifted margin Composite TSE (CTSE). The latter comprises post-breakup oceanward prograding successions. If the pre-rift TSE continues onto the continent beyond the rifted margin, it made or included in a CTSE mapped on the adjacent continent (a Continental platform CTSE in this illustration). Structural geometries for this drawing are adapted from Sutra et al. (2013).

**Figure 3.** A schematic drawing illustrating typical tectono-sedimentary elements in a foreland and in an intracratonic settings. Vertical and horizontal scales are generalized approximations. Left part of the sketch illustrates a CTSE typical for a foreland setting along margins of old cratons. In the right part, there is a CTSE typical for an intracontinental setting. Note synorogenic inversion in the intracontinental basin.

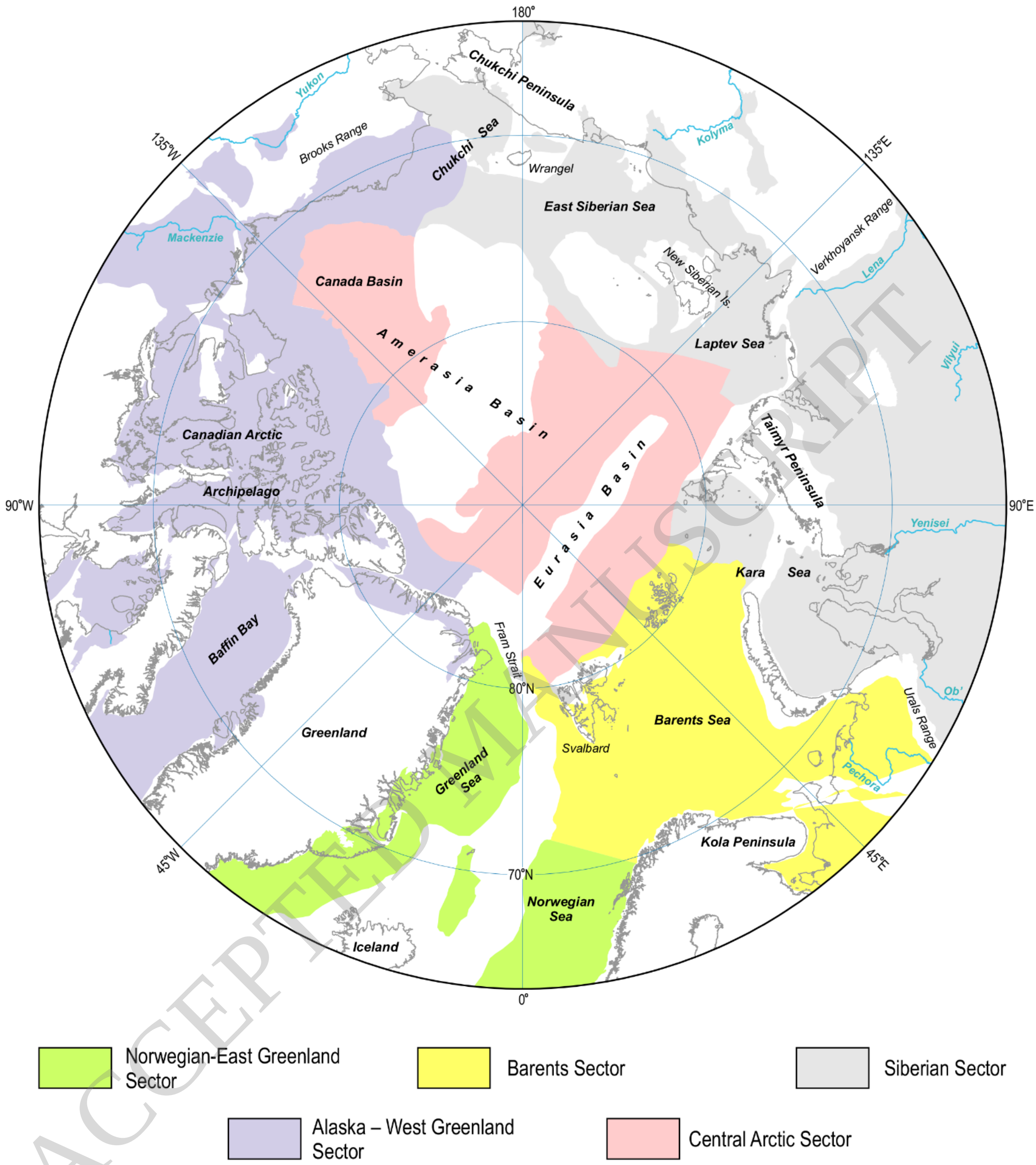
180°
135°W
135°E
90°W
90°E
45°W
45°E
0°
80°N
70°N
Chukchi Peninsula
Yukon
Brooks Range
Chukchi Sea
Wrangel
Kolyma
East Siberian Sea
Mackenzie
New Siberian Is.
Verkhoyansk Range
Lena
Canada Basin
Amerasia Basin
Laptev Sea
Vilyui
Canadian Arctic
Archipelago
Taimyr Peninsula
Eurasia Basin
Yenisei
Kara Sea
Baffin Bay
Fram Strait
Ob'
Urals Range
Greenland
Barents Sea
Svalbard
Greenland Sea
Pechora
Kola Peninsula
Norwegian Sea
Iceland
Norwegian-East Greenland Sector
Barents Sector
Siberian Sector
Alaska – West Greenland Sector
Central Arctic Sector



**Figure 1**

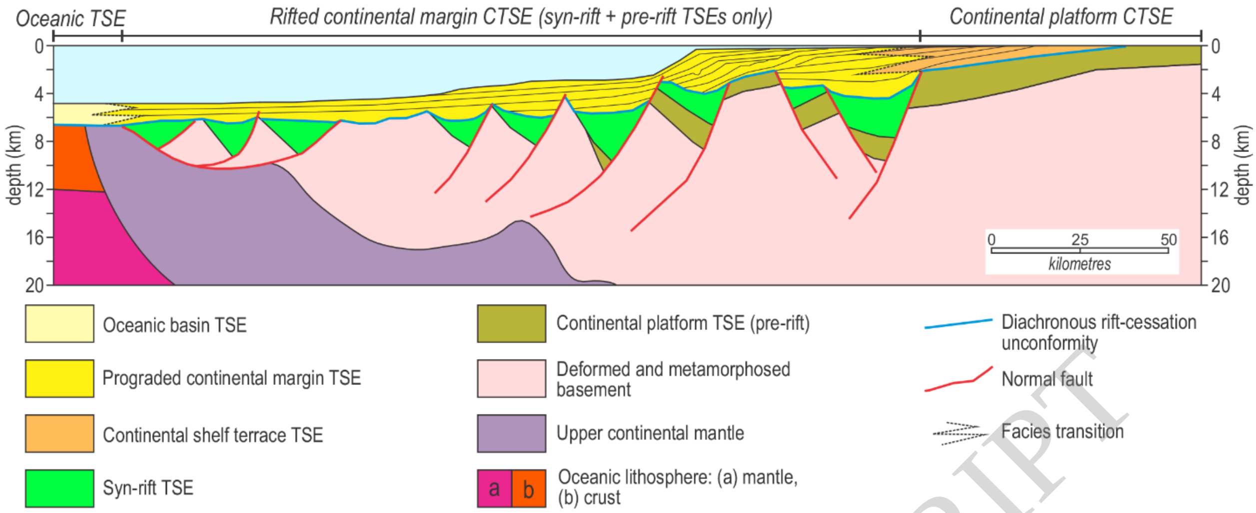
Oceanic TSE
Rifted continental margin CTSE (syn-rift + pre-rift TSEs only)
Continental platform CTSE
depth (km)
0
4
8
12
16
20
0
25
50
kilometres
Oceanic basin TSE
Prograded continental margin TSE
Continental shelf terrace TSE
Syn-rift TSE
Continental platform TSE (pre-rift)
Deformed and metamorphosed basement
Upper continental mantle
a
b
Oceanic lithosphere: (a) mantle, (b) crust
Diachronous rift-cessation unconformity
Normal fault
Facies transition



**Figure 2**

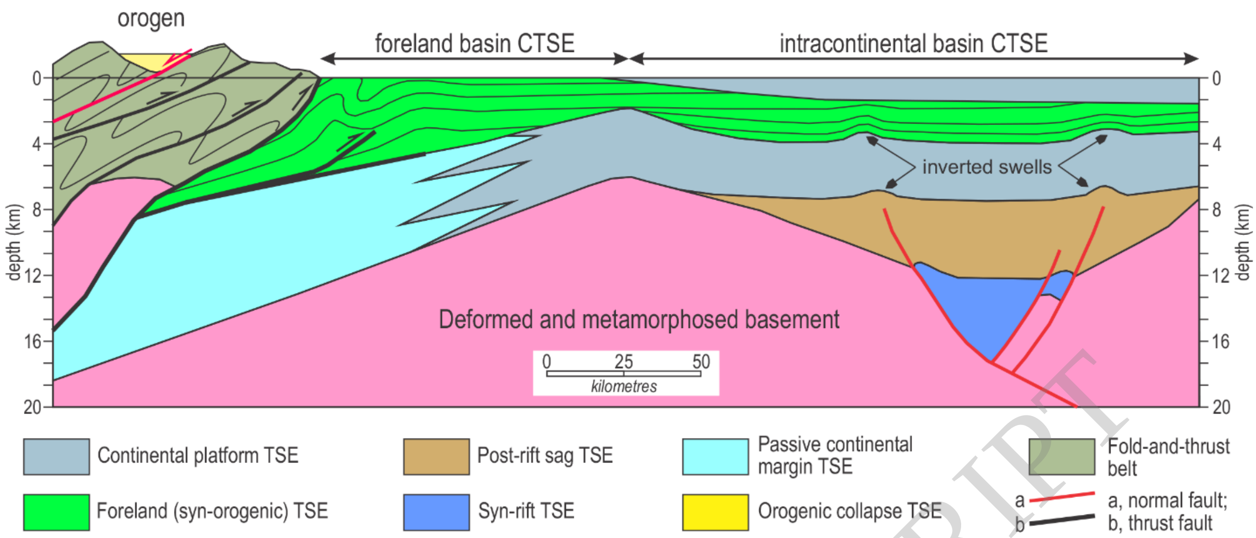
orogen
foreland basin CTSE
intracontinental basin CTSE
inverted swells
Deformed and metamorphosed basement
0 25 50
kilometres
depth (km)
0
4
8
12
16
20
Continental platform TSE
Foreland (syn-orogenic) TSE
Post-rift sag TSE
Syn-rift TSE
Passive continental margin TSE
Orogenic collapse TSE
Fold-and-thrust belt
a, normal fault;
b, thrust fault



**Figure 3**