



**Palynofacies Analyses of Fox Bay Formation (Devonian), Falkland Islands**  
Análise de Palinofácies da Formação Fox Bay (Devoniano), Ilhas Malvinas

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Recebido em: 12/08/2018 Aprovado: 12/11/2018

DOI: [http://dx.doi.org/10.11137/2019\\_1\\_07\\_19](http://dx.doi.org/10.11137/2019_1_07_19)

**Abstract**

The Falkland Islands are an archipelago consisting two main islands (West and East) that show contrasts in their sedimentary history. The palynofacies analysis was applied as tool for reconstructing the history of sedimentary organic matter deposition during the Devonian. The material derives from the Fox Bay Formation that crops out in the East and West Falklands. Spore Color Indices (SCI) and Total Organic Carbon (TOC) also were conducted. Seven kerogen categories were identified: amorphous organic matter (AOM), opaque phytoclasts, *Spongiophyton*, acritarchs, prasinophycean algae and spores. In general, the samples are carbonized, in particular the AOM that is most abundant, and are distinguished into two subgroups: amorphous organic matter (AOM) and amorphous organic matter carbonized (AOMc). Four palynofacies associations were identified: Palynofacies A, which is composed of prasinophycean algae and acritarchs, Palynofacies B of spores and AOMc, Palynofacies C of phytoclasts and *Spongiophyton*; and Palynofacies D only of AOM. The results confirm a differentiation between the West and East islands. In fact, this reflects the abundance of AOM and AOMc, respectively. In West Falkland the sedimentary organic matter is not completely carbonized indicated by a lower abundance of AOMc as a result of a lesser thermal influence caused probably by movement of the Hornby Mountains Fault.

**Keywords:** Palynofacies; Fox Bay Formation; Devonian rocks; Falkland Islands

**Resumo**

As Ilhas Malvinas são um arquipélago constituído por duas ilhas principais (Grande Malvina e Soledad) que apresentam contrastes na sua história sedimentar. Análise de palinofácies foi aplicada como ferramenta para reconstruir os paleoambientes baseado na deposição da matéria orgânica sedimentar. O material é derivado da Formação Fox Bay, que se desenvolve nas ilhas Grande Malvina e Soledad. Análise de Índice de Coloração de Esporos (ICE) e Carbono Orgânico Total (COT) também foram realizadas. Sete categorias de querogênio foram identificadas: matéria orgânica amorfa (MOA), matéria orgânica amorfa carbonizada (MOAc), fitoclastos opacos, *Spongiophyton*, acritarcos, prasinófitas e esporos. Em geral, as amostras estão carbonizadas, em particular a MOA, que é o tipo mais abundante, e são distinguidas em dois subgrupos: matéria orgânica amorfa (MOA) e matéria orgânica amorfa carbonizada (MOAc). Quatro associações de palinofácies foram identificadas: Palinofácies A, composta por prasinófitas e acritarcos, Palinofácies B por esporos e MOAc, Palinofácies C por fitoclastos e *Spongiophyton* e Palinofácies D apenas por MOA. As análises confirmam diferenças na sedimentação entre as ilhas Grande Malvina e Ilha Soledad, indicada principalmente pela alta abundância de MOA e MOAc, respectivamente. Em West Falkland, a matéria orgânica sedimentar não está completamente carbonizada, indicada por uma menor abundância de AOMc, como resultado de uma menor influência térmica causada provavelmente pelo movimento da Hornby Mountains Fault.

**Palavras-chave:** Palinofácies; Formação Fox Bay; Devoniano; Ilhas Malvinas

## 1 Introduction

The Falkland Islands are an archipelago consisting two main islands (East Falkland, ca. 6700 km<sup>2</sup>, and West Falkland, ca. 5300 km<sup>2</sup>), and several hundred islands in the South Atlantic Ocean, lying 600 km east of Argentina between latitudes 51°00' S and 52°30' S, and longitudes 57°30' W and 61°30' W (Figure 1).

According to Hyam *et al.* (2000), the sedimentary history, thermal maturity and kerogen facies allow to distinguish between the East and West Falkland Islands.

Palynofacies analysis is an interdisciplinary approach where not only the palynomorphs in the palynological slides are investigated, but the entire organic content of the slides. The particles are viewed as sedimentary components that reflect ori-

ginal conditions in the source area and the depositional environments. The palynofacies concept has been successfully applied to study sediments and sedimentary rocks of different ages in very diverse depositional settings (e.g. Combaz, 1964; Boulter & Riddick, 1986; Oboh, 1992; Traverse, 1994; Tyson, 1995, Oboh-Ikuenobe & De Villiers, 2003). This is the first time that such a palynofacies approach has been applied in Falkland Islands. The investigation reported here concerns to identify and classify the kerogen categories and to determine its spatial variations in the Devonian of Fox Bay Formation. Special attention was paid to the comparison, based on sedimentary organic matter (SOM), between the two main islands of the Falkland Islands.

## 2 Geological Setting

According to Johnston (2000), there is tectonic evidence that the Falklands represent a displaced

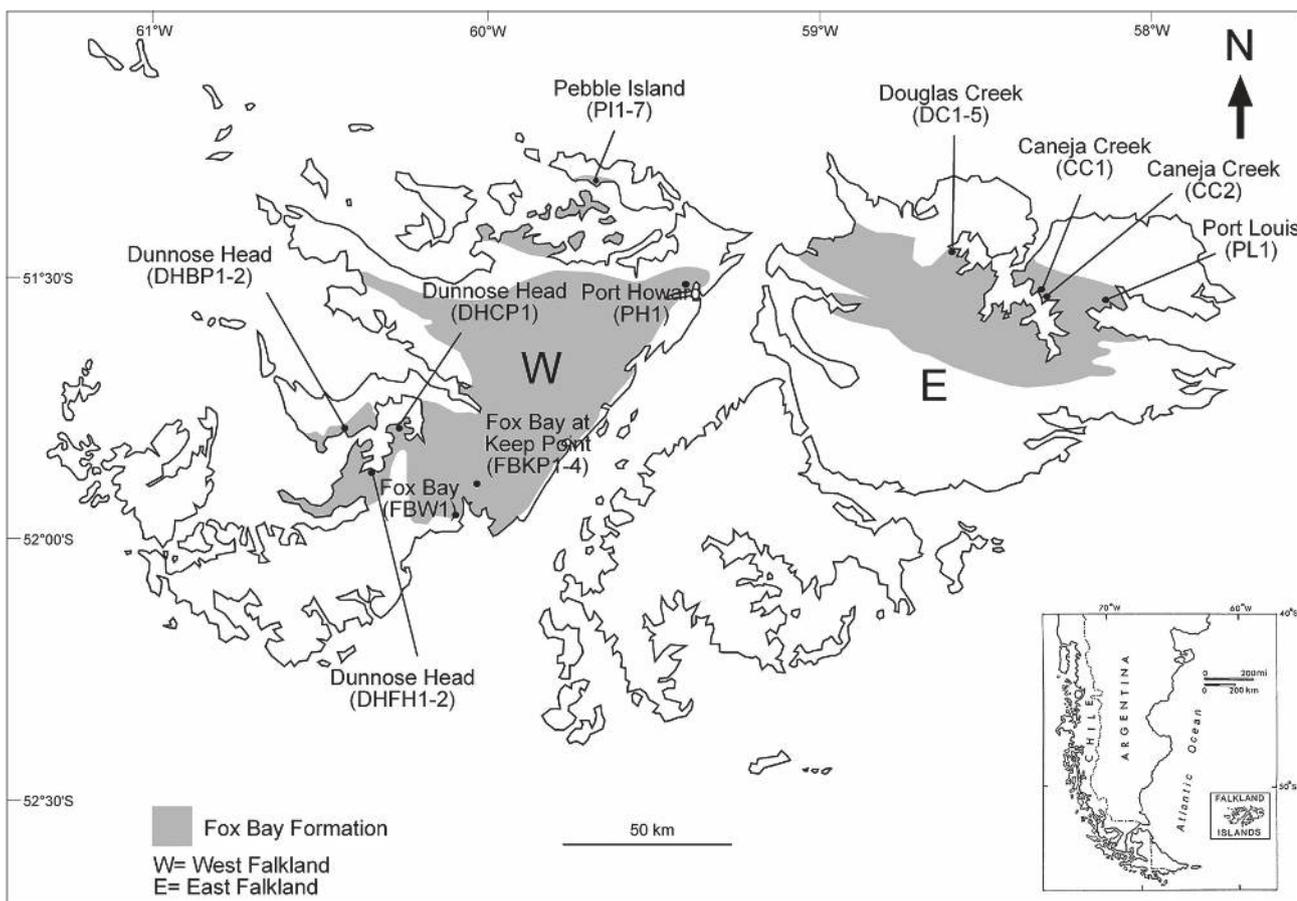


Figure 1 Map of Falkland Islands showing the locations of outcrops and the distribution of Fox Bay Formation (adapted from Aldiss & Edwards, 1999 and Thomson *et al.*, 2002)

segment of the Cape Fold Belt of South Africa. Post-Paleozoic metamorphic events involving the Cape Fold Belt also affected the Fox Bay Formation (especially in East Falkland, where it is usually metamorphosed to green schist facies and its fossils are often sheared and distorted). However, the deformation in West Falkland is much less intense and fossils are better preserved in the formation (Carvalho, 2006). According to Johnston (2000), the islands have been rotated clockwise by at least 150 degrees since moving from their original paleogeographical position close to South Africa, with an initial rotation of 90 degrees during oroclinal bending, followed by a further phase of solid body rotation (at least another 60 degrees). As consequence, the West Falkland was originally situated to the east of East Falkland in the Devonian.

## 2.1 Stratigraphy

The sedimentary history of the Falkland Islands starts in the Silurian?; however, only from Devonian age a significant thickness of clastic sediments was deposited. According to Aldiss & Edwards (1999), the Paleozoic rocks of the Falkland Islands has been divided into two groups: West Falkland Group (?Silurian-Devonian) and Lafonia Group (Late Carboniferous—Permian). The West Falkland Group is about 5 km thickness and consists of the Port Stephens, Fox Bay, Philomel and Port Stanley formations (Aldiss & Edwards 1999) (Figure 1). The present study concentrated on the Fox Bay Formation, which is in average 800 m thickness.

The Fox Bay Formation consists predominantly of fine- to medium-grained sandstones intercalated with siltstones and shales. This formation is recognized on the two main islands, where it is more evident on West Falkland (Figure 1). The successions in West and East Falklands show five major sandstone packages alternating with five shales, but the East Falkland sequence is far more shale rich, with about 60% shales compared to approximately 15% on West Falkland (Hyam *et al.*, 2002). These indicate a shallower depositional environment for West Falkland in contrast to a deeper water environment in East Falkland, inferring proximal and distal facies, respectively.

The Fox Bay Formation is rich in marine fossils, being the brachiopods and trilobites, the most common (Aldiss & Edwards, 1999). These fossils confer an Lower Devonian age for the formation. More detailed, Carvalho (2006), based on trilobite fauna, suggests Pragian age for the same localities studied in this work. Recently, Marshall (2016) recorded of chitinozoan *Ramochitina magnifica* in the formation, which is currently used as a Pragian indicator in Bolivia and Brazil.

## 3 Localities and Outcrop Descriptions

The samples from Fox Bay Formation were collected from localities in both East and West Falkland (Table 1).

Sample code	Location	Lat/Long
E1-CC1	Caneja Creek, Port Salvador	51°30' S/58°23' W
E2-CC2	Caneja Creek, Port Marsey	51°32' S/58°16' W
E3-DC1	Douglas Creek	51°23' S/58°32' W
E3-DC2		
E3-DC3		
E3-DC4		
E3-DC5		
E4-PL1	Port Louis Farm, Port Louis	51°30' S/58°06' W
W1-DHBP1	Dunnose Head, Black Pool Beach	51°45' S/60°28' W
W1-DHBP2		
W2-DHCP1	Dunnose Head, Port Philomel	51°44' S/60°19' W
W3-DHFB1	Dunnose Head, Ferry Hill	50°50' S/60°19' W
W3-DHFB2		
W4-FBEKP1	Fox Bay at Keelp Point	51°55' S/60°03' W
W4-FBEKP2		
W4-FBEKP3		
W4-FBEKP4		
W5-FBW1	Fox Bay West	51°57' S/60°05' W
W6-PH1	Port Howard	51°39' S/59°33' W
W7-PI1	Pebble Island	51°18' S/59°38' W
W7-PI2		
W7-PI3		
W7-PI4		
W7-PI5		
W7-PI6		
W7-PI7		

Table 1 Summary of localities of Fox Bay Formation sampled for this study. E= East Falkland, W=West Falkland

### 3.1 East Falkland

In the East Falkland, the sample were collected at coastal outcrops, including Port Louis (01

sample, E4-PL1), Port Salvador inlet (02 samples Caneja Creek site, E1-CC1- E1-CC2) and Douglas Settlement (05 samples, Douglas Creek site, E3-DC1- E3-DC5) (Figure 1).

In the Caneja Creek, the two samples were collected in two distinct outcrops (Table 1), but both with the same characteristics, about 4 m of friable, dark brown to black silty shales and thin, laminated, very fine-grained sandstone. The two samples were collected from the shales.

Five samples were collected in one outcrop in the Douglas Creek site, near Douglas Settlement. The lower part of the outcrop consists of black shales intercalated with thin sandstone beds that become increasingly well developed in the upper part of the sequence. The samples were also collected from shales.

### 3.2 West Falkland

In the West Falkland, the samples were collected in three different areas:

#### *(1) In the south*

- Fox Bay at Keelp Point (04 samples, W4-FBEKP1-W4-FBEKP-4). The outcrop consists of the fine to coarse grained sandstones; small channel cross-bedding; some round intraclasts of black shales.
- Fox Bay West (01 sample, W5-FBW1). The outcrop from Fox Bay West site consists of the shales and medium grained sandstones.

#### *(2) In the central area*

- Dunnose Head:

Dunnose Head at Black Pool Beach (02 samples, W1-DHBP1-W1-DHBP2). The outcrop consists of the medium to coarse grained sandstones; middle to big channel cross-bedding; fine laminated sandstones or with climbing ripples intercalated with vegetal organic matter.

Dunnose Head at Port Philomel (W2-DHCP1). In this site, the outcrop consists of the medium grained sandstones, with cross-bedding and some round intraclasts of black shales.

Dunnose Head at Ferny Hill (W3-DH-FH1-W3-DHFH2). The outcrop of this site shows the same characteristics than at Port Philomel.

- In the Port Howard site (W6-PH1). The outcrop consists of brownish shales and silts-tones.

#### *(3) In the north*

- Pebble Island (PI1-PI-7). The Fox Bay Formation was sampled at coastal sections around the island. The samples are from the black shales and siltstone layers.

## 4 Material and Methods

The sample were collected in expedition (February 2000) conducted by American Museum of Natural History, with the aim of visiting new fossiliferous localities and to collect new material from previously documented sites in West Falkland and from new localities in both East and West Falkland.

The twenty-six rock samples were prepared using palynology method from those of according to Tyson (1995), Carvalho (2001) and Mendonça Filho *et al.* (2010) and involved the destruction of all the mineral constituents by hydrochloric and hydrofluoric acids. The samples were not oxidized.

The palynological slides are stored in the Department of Geology, Federal University of Rio de Janeiro (Rio de Janeiro, RJ). The samples used for palynofacies analyses were prepared at the Department of Geology of Federal University of Rio de Janeiro, Rio de Janeiro, Brazil.

### 4.1 Palynofacies Analysis

Tyson (1995) defined palynofacies as “a body of sediment containing a distinctive assemblage of palynological organic matter thought to reflect a

specific set of environmental conditions or to be associated with a characteristic range of hydrocarbon-generating potential.” The palynological organic matter or kerogen was defined by the same author as “the particulate organic matter residue isolated from a sedimentary rock after complete dissolution of the rock matrix by HCl and HF (non-oxidative) acids.”

In each sample, ca. 300 particles were counted using transmitted light microscopy. Due to the high degree of carbonization of the organic matter, dark-field was also employed, especially for samples with content of opaque phytoclasts.

An extensive description of the dispersed organic matter can be found in the literature (e.g., Boulter & Riddick, 1986; van der Zwan, 1990; van Bergen, *et al.*, 1990; Steffen & Gorin, 1993a, 1993b; Tyson, 1995; Batten 1996, Oboh & Yepes, 1996; Oboh-Ikuenobe *et al.*, 1997; Mendonça Filho *et al.*, 2002; Oboh-Ikuenobe *et al.*, 2005; Carvalho, 2006a). The scheme used to classify dispersed organic matter with transmitted light microscopy was derived from Mendonça Filho *et al.* (2011).

#### 4.1.1 Kerogen Distribution

In marine environments the proximal-distal trend is one of the most important controls on kerogen distribution. For detailed marine environmental analyses several kerogen distribution trends and parameters have been used (Tyson, 1993, 1995). These trends and parameters are based on percentages of either the total kerogen phytoclasts or palynomorph assemblages.

A large percentage of amorphous organic matter (AOM) results from a combination of good preservation and low-energy environments. The preservation of AOM is directly related to dysoxic-anoxic conditions and consequently, but not necessarily, correlated with primary productivity (Tyson, 1993). According to Tyson (1993), in carbonate facies the AOM may be the only kerogen available for preservation.

High percentages of phytoclasts are mostly related to proximal depositional conditions. The main controlling factor is the short transport of the particles. Other factors, such as oxidizing conditions and the relative resistance of the tissues are also associated with proximity of source area (Mendonça

Filho, 1999). Generally, large amounts of phytoclast particles are deposited by rivers in estuaries and delta, both close to shorelines. However, redeposition also occurs in deep waters by turbidity currents (Habib, 1982).

The palynomorph group is the least abundant of the three main groups; therefore its occurrence is largely controlled by AOM and phytoclast dilution (Tyson, 1993). Large percentages of palynomorphs, dominated by sporomorphs, indicate a proximity to terrestrial sources and is usually associated with oxygenated environments; consequently, a small amount of AOM is observed as a result of low preservation. With moderate proximity to land greater percentages of palynomorphs can also be found, as dilution by phytoclasts decreases (Tyson, 1995). If microplankton dominates the palynomorph group, the environment may be of a distal shelf, with adjacent land areas being generally arid, oxygenated and with low ‘AOM’ preservation and perhaps high productivity. The abundance of microplankton is inversely related to that of the sporomorphs (Tyson, 1993). Depending on the type of microplankton, the ratio of sporomorphs to phytoplankton reflects the proximal-distal trend.

#### 4.2 Spore Color Index (SCI)

The spore color index (SCI) of the Fugro-Robertson Group is the most widely used spore color scale. The index is based on single-grain palynomorph mounts of spore/pollen with having a numerical scale ranging from 1-10 with 10 being the most mature. According to Marshall (1991) and Marshall & Yule (1999), the SCI is based on a series of 19 single-grain palynomorph individual mounts determined by a single operator. Gutjahr (1966) conducted the first study on the changes of spore color. However, Staplin (1969), too related the change in spore coloration with the increase thermal conditions during the burial of the organic matter.

#### 4.3 Total Organic Carbon Determination

The geochemical analyses were performed in the Geochemistry Section of Petrobras, Rio de Janeiro, Brazil. The geochemical methods employed in this study included only the Total Organic Carbon (TOC) determination using combustion of samples

after rock samples acidification to remove the inorganic carbon.

The accumulation of organic matter (OM) in sediments was estimated using TOC analysis. According to Tyson (1995), TOC analysis is a convenient method to determine the relative abundance of OM in sediments. The accumulation of OM is controlled by major factors such as primary product, water depth and sediment grain size. TOC is always controlled by three main variables: input of OM, preservation of the supplied OM, and dilution of the OM by sediment accumulation (Tyson, 1995). The values of TOC in marine rocks range from ca. 0.1% (deep-sea pelagic deposits) to 94% (coals) (Tyson, 1995).

#### 4.4 Cluster Analysis

Cluster analysis was employed based on percentage and composition of kerogen components, in order to establish groupings and to recognize the relationship between the ones. The compositional data was performed a centered log-ratio transformation prior to cluster analysis. To identify the divisions of the studied succession based on palynofacies approach, Q-mode (cluster of samples) and R-mode (cluster of kerogen groups) cluster analyses were performed on counts of kerogen using the computer program STATISTICA (1984-2000). This cluster analysis forms discrete groupings that are based on the characteristics (percentage) of the objects. The results are clearly displayed in dendrograms, which when combined, allowed assessment reasons for clustering.

### 5 Results

#### 5.1 Kerogen Categories

The particulate organic matter typically consisted of seven categories of kerogen: amorphous organic matter (AOM), amorphous organic matter carbonized (AOMc), opaque phytoclasts, *Spongiophyton*, acritarchs, prasinophycean phycmata and spores (Figure 2).

The AOM was the most abundant in the studied samples (51.3% of total of kerogen). The preservation was poor because of carbonization. AOM

was found to be more abundant on West Falkland. The second most abundant is an amorphous organic matter heavily carbonized denominated here as AOMc. It was here separate because is clearly distinguishable and shows a preferential pattern of distribution, being more abundant in the East Falkland.

The phytoclasts were not abundant in the material but, also like AOM, were more abundant in West Falkland. Two components were recognized in the Phytoclast group: opaque particles and *Spongiophyton*. The first are derived primarily from the oxidation of translucent (non-opaque) material or natural pyrolysis (Mendonça Filho, 2011). The second are spongy surface fragments of the enigmatic genus *Spongiophyton*, which are defined as nonvascular land plant fossil (Gensel *et al.*, 1991).

In the Palynomorph Group, spores, prasinophycean phycmata and acritarchs (Figure 2) were recognized. The prasinophycean algae are the most abundant, but only the genus *Leiosphaeridia* is recorded. Two genera of acritarch were recorded: *Hapsidopalla* and *Goniosphaeridium*. The palynomorphs were carbonized and therefore difficult to identify to the species level.

#### 5.2 Description of Palynofacies

Four palynofacies were revealed by cluster analyses (Figure 3). The palynofacies are designated palynofacies A, B, C and D. The major break that occurred between clusters A and B and C and D is strongly related to the relative proportions of AOM and AOMc. The proportions of different groups of kerogen are shown in Figure 4.

##### 5.2.1 Palynofacies A

Palynofacies A is composed of prasinophycean algae and acritarchs. This palynofacies has been recovered especially in the Pebble Island (PI) locality (Figure 4). The phytoplankton assemblage is not taxonomically diverse. The palynofacies contains a moderate to high proportion of prasinophyceans represented only by the genus *Leiosphaeridium*. The prasinophyceans generally constituted less than 10% of the kerogen except in the samples from Pebble

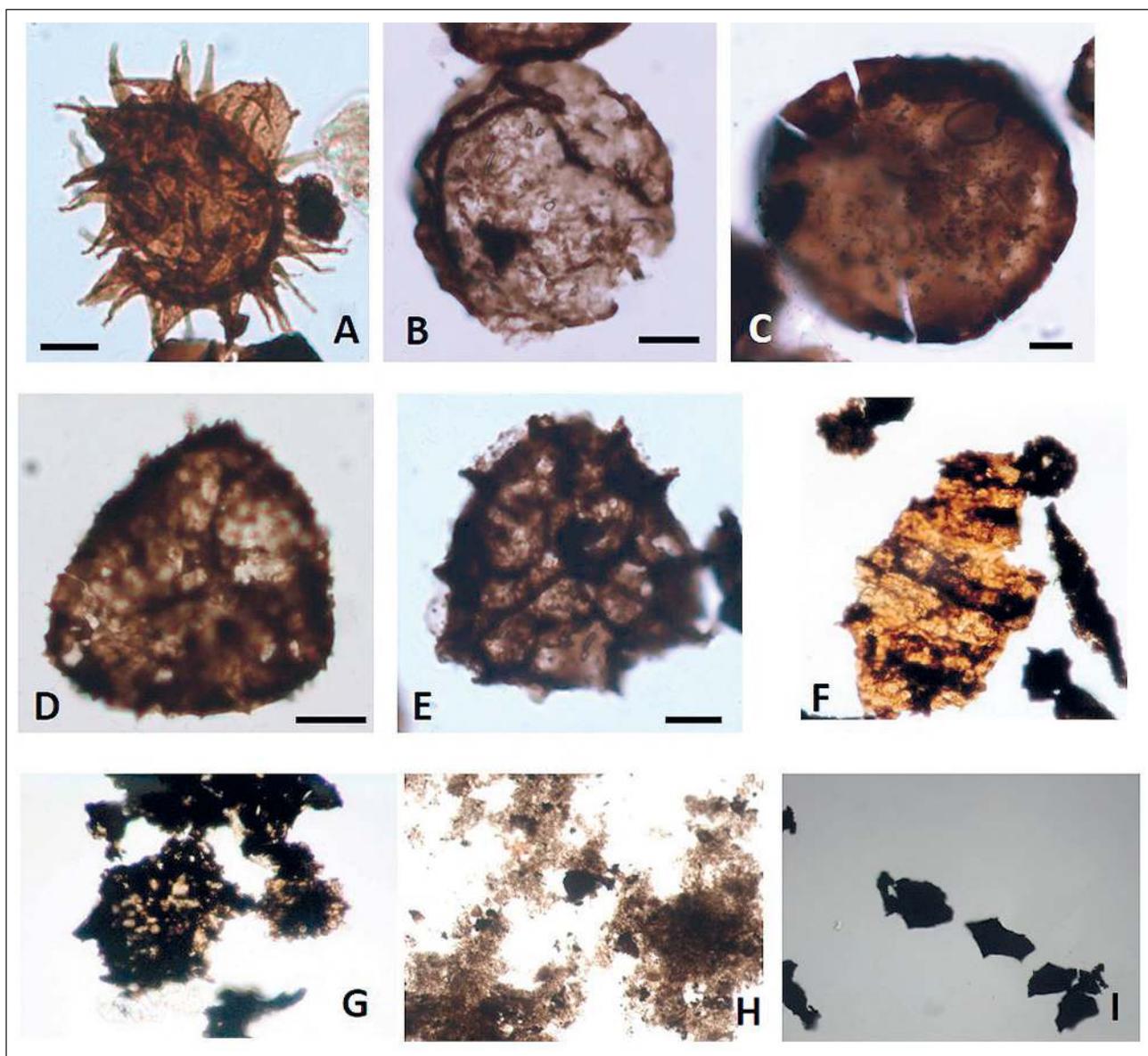


Figure 2 Categories of kerogen found in the samples: A) acritarch acantomorph; B-C) prasinophycean *Leiosphere*; D-E) trilete spore; F) *Spongiophyton*; G) carbonized amorphous organic matter; H) amorphous organic matter; I) opaque phytoclasts.

Island (PI), where it was as high as 33% of the total kerogen. The acritarchs occur also in Pebble Island location, but in very low abundances. Single specimens of *Hapsidopalla* and *Goniosphaeridium* occur in some samples.

### 5.2.2 Palynofacies B

It is described from all studied samples; however, it shows clearly a higher abundance in samples of the east than of the west Falkland. The Palyno-

facies B is composed of AOMc and spores, where carbonized amorphous organic matter (AOMc) is conspicuously most abundant. The AOMc is finely dispersed matter, non-fluorescent and heavily carbonized (see Figure 1). A single spore is found only in the sample W5-PH1.

### 5.2.3 Palynofacies C

Palynofacies C is composed of opaque phytoclasts and *Spongiophyton*, being the first more

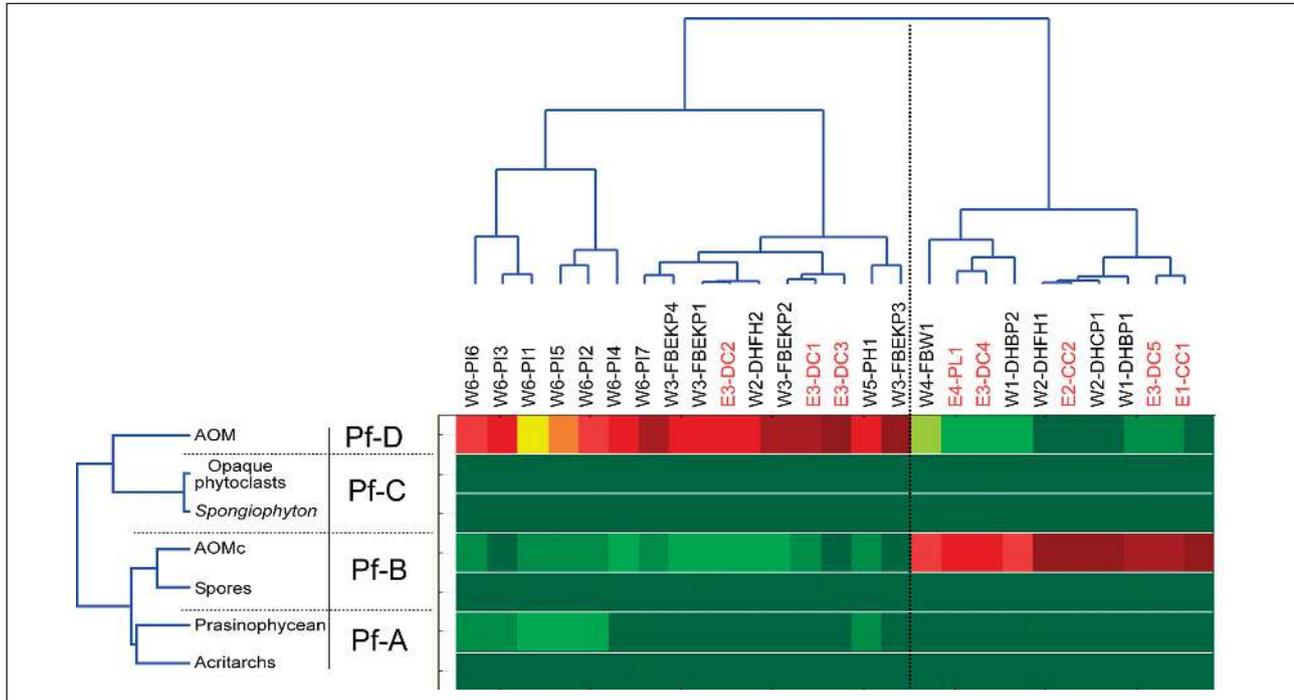


Figure 3 Dendrogram two-ways (R- and Q-mode) of studied locations from the Falkland Islands showing the grouping of samples (Q-mode) and kerogen categories (R-mode)

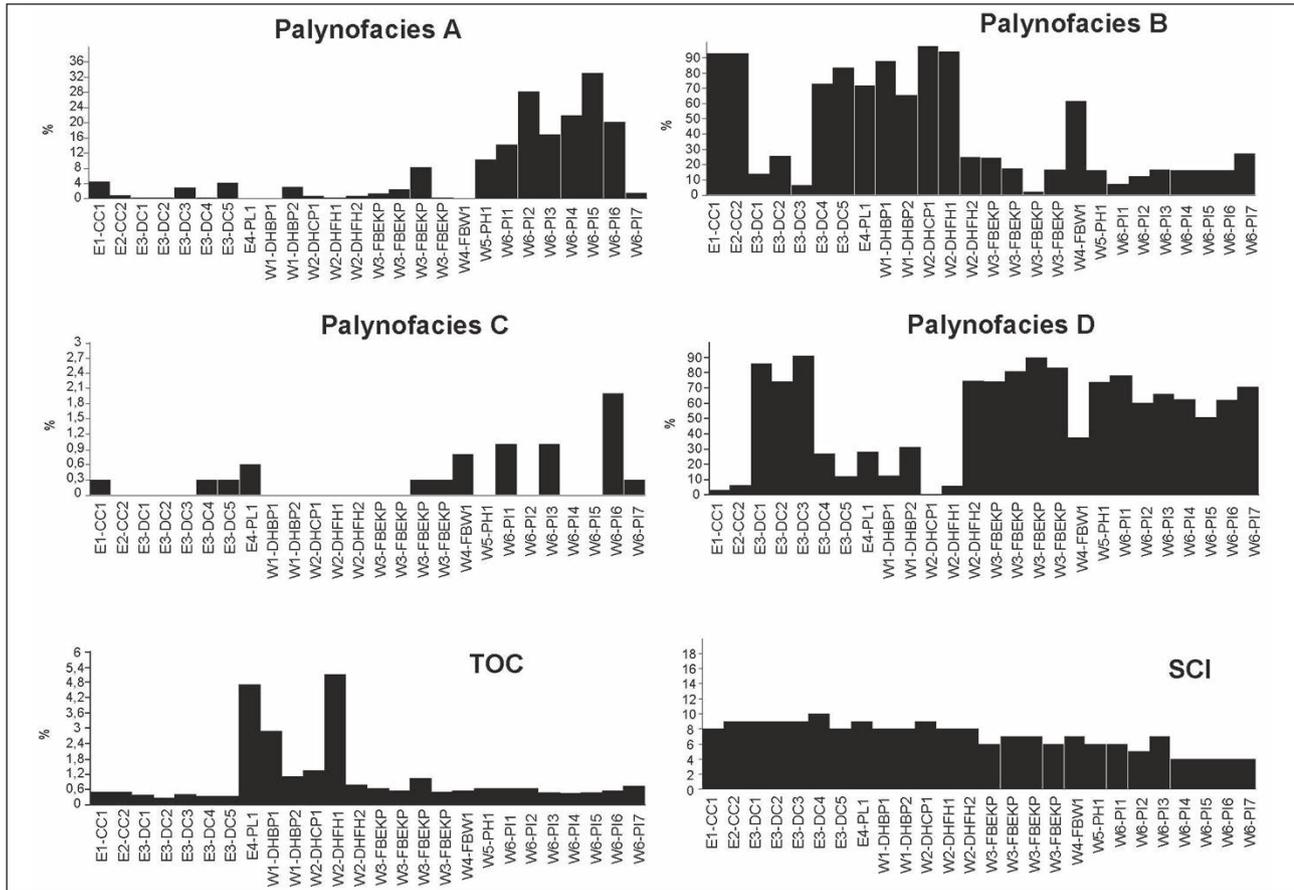


Figure 4 Palynofacies, Total Organic Carbon (TOC) and Spore Index Color (SCI) values for each studied samples

abundant than the last. This palynofacies has been recovered only in 8 samples, and shows the lowest abundance of the palynofacies. However, it is more abundant in the Pebble Island (PI) location (Figure 4). This palynofacies also occurs in Fox Bay Formation, but in very low proportion. *Spongiophyton* is found only in the sample W4-FBW1.

#### 5.2.4 Palynofacies D

This palynofacies is constituted only of amorphous organic matter. The AOM is slightly fluorescent and is most abundant component of kerogen. Despite the wide distribution, it shows clearly a trend of higher abundance in West Falkland (Figure 4). There is a distinct reverse relationship between the relative abundances of the AOM and AOMc.

#### 5.3 Total Organic Carbon (TOC)

TOC of samples ranged from 0.25% (DC2) to 5.11% (DHFH1). The overall mean was 1.0%. The TOC values showed an unclear difference between the samples from the West (1.1%) and East (0.9%) Falklands (Figure 4). The samples from Dunnose Head (W1-DHBP1, W1-DHBP2, W1-DHCP1, W2-DHFH1) recorded the highest average TOC (2.23%).

#### 5.4 Spore Color Index (SCI)

The qualitative and quantitative spore color measurements indicate mature thermal conditions for the studied samples. The SCI values range from 4.0 to 10.0, and the average was 6.9. The colors of the organic constituents, especially AOM, would have been significantly altered to dark brown and black if the sediments had experienced supermature thermal conditions. The inferred burial temperatures of 150°->250° are in general agreement with the geothermal gradient of the West and East Falkland (Thomson *et al.*, 2002). A conspicuous difference between West and East Falkland is observed. In West Falkland the average is 6.3, whereas 8.9 is recorded for East Falkland (Figure 4).

### 6 Discussion

Previous works on distribution of components of kerogen (e.g. Boulter and Riddick, 1986; Van

der Zwan, 1990; Steffen & Gorin, 1993a, 1993b; Van Bergen, *et al.*, 1990, Tyson, 1995; Batten 1996, Oboh-Ikuenobe & Yepes, 1996, Oboh-Ikuenobe *et al.*, 1997; Oboh-Ikuenobe *et al.*, 2005) in marine sediments show explicitly that the absolute abundance of amorphous organic matter is observed in more offshore or marine restricted environments (Tyson, 1995). The marine palynomorphs (prasinophyceans and acritarchs) confirm the marine environment. This is more evident in sediments from the Pebble Island because probably a better preservation of the organic matter.

The scarce presence of land derived (opaque phytoclasts, spores, *Spongyophyton*) in the samples can be interpreted by two ways: (1) according to Meadows (1999), the Devonian succession records an overall marine transgressive-regressive system and the lower abundance of land derived would have been deposited during the transgressive phase, when these constituents decline; and (2) lower proportion associated to poor preservation and carbonization of the material. According to Marshall (2016), the characteristic transgressive of the Fox Bay Formation allows regional correlations, including the Ponta Grossa Formation, Paraná Basin, Brazil.

The studied samples are not distinguished only by composition and abundance, but also by degree carbonization of constituents. The results show that the East and West Falkland can be distinguished by the palynofacies distribution (Figure 5). The difference has been shown more conspicuous using the palynofacies B and D (see Figure 3) In fact; this reflects the lower or higher abundance of AOM and AOMc, respectively.

The AOM from Palynofacies D predominate clearly in all samples of West Falkland (figure. 4 and 5); their percentages varied between 75% and 84%, whereas most of the samples from East Falkland show higher abundance of AOMc from Palynofacies B. Even these two elements naturally co-vary. The graphs showing stratigraphic trends were compared to each other (SCI *versus* Palynofacies B, SCI *versus* Palynofacies D and AOM *versus* AOMc) (Figure 6) to determine which components co-vary: SCI-Palynofacies B co-vary, but the covariance of SCI-Palynofacies D and AOM-AOMc are not remarkable.

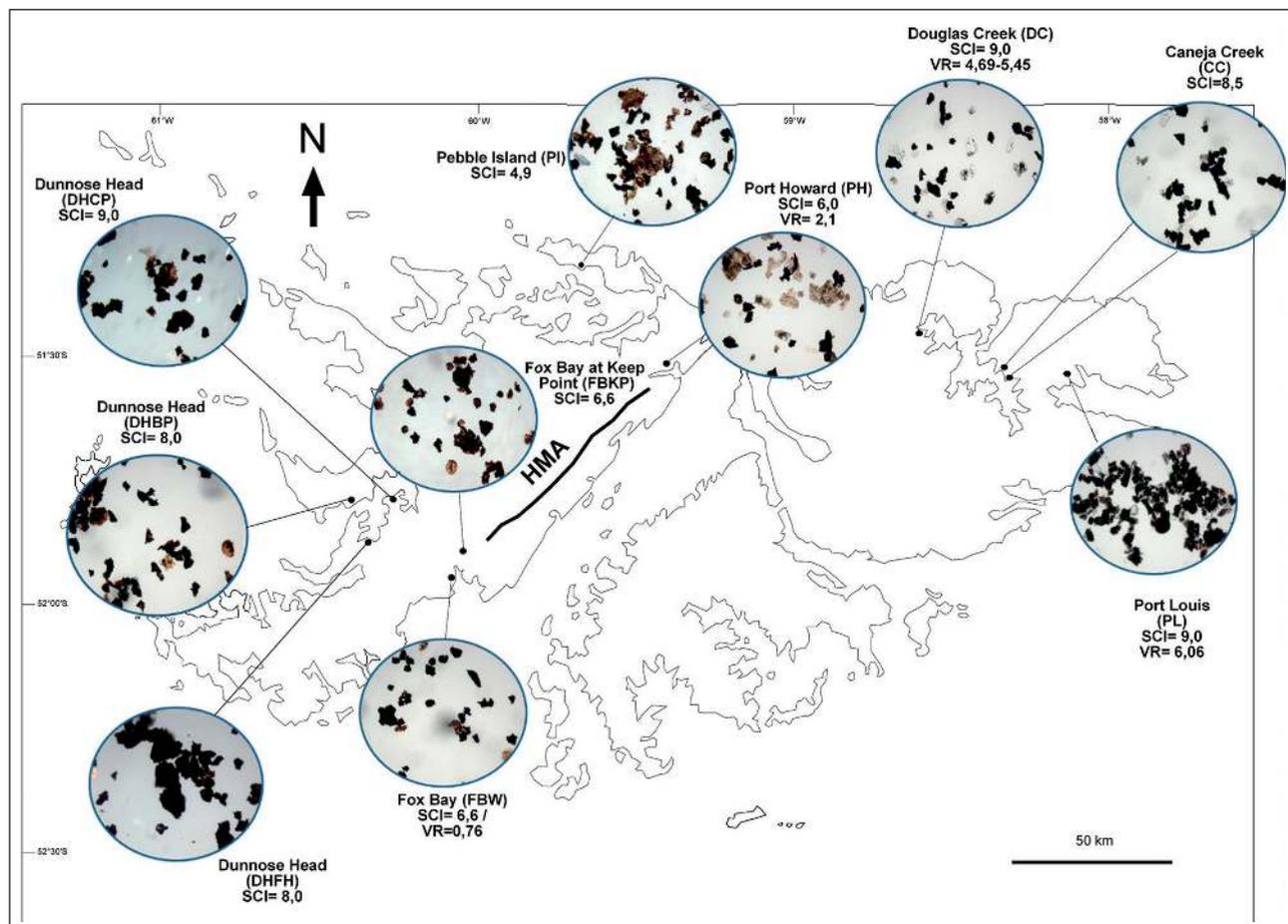


Figure 5 Summarized difference in kerogen composition, SCI and vitrinite reflectance (from Thomson *et al.*, 2000 and from Hyam *et al.*, 2000 for Port Howard location). HMA – Hornby Mountain Anticline

All samples from East Falkland have SCI show values  $>8.0$ . These results corroborate the high values of vitrinite reflectance ( $>3.0\%$ ) found by Hyam *et al.* (2000) and thereby indicating a post-mature stage. The vitrinite reflectance values ( $R_v$ ) obtained by Hyam *et al.* (2000) from the Fox Bay Formation show that West Falkland has low  $R_v$  values (av.  $1.7\%$   $R_v$ ), while East Falkland has a high  $R_v$  values (av.  $3.6\%$   $R_v$ ). Still, according to Hyam *et al.* (2000), the contrast in  $R_v$  between East and West Falkland clearly shows that West Falkland has always been buried to a much shallower depth than East Falkland, caused by reactivation of the Hornby Mountains Fault. These authors believe that the Hornby anticline is a large, isolated fold that affected the West Falkland Group along a NE-SW axis on West Falkland and in Falkland Sound. West Falkland is uplifted relative to East Falkland, and gives a struc-

tural relief that increases from 3 km in the north to 6-8 km in the south.

Oboh-Ikuenobe *et al.* (2003) pointed out that the interaction among several factors such as climate and vegetation, the mode and length of transportation, deposition, rate of burial, post-burial changes, and tectonism affects the types of kerogen and their distribution in sediments (e.g., Strel & Richelot, 1994; Batten, 1996a; Cirilli *et al.*, 1998; Jaramillo & Oboh-Ikuenobe, 2003, Oboh-Ikuenobe *et al.*, 1999). The most common factors studied are provenance and depositional environmental conditions (Van Waveren, 1989; Oboh, 1992; Gastaldo & Staub, 1997; Tyson & Follows, 2000). However, few studies have examined how tectonism affects the deposition and preservation of organic matter.

Oboh-Ikuenobe *et al.* (1997) studied the effects of tectonism and subsidence on palynofacies in

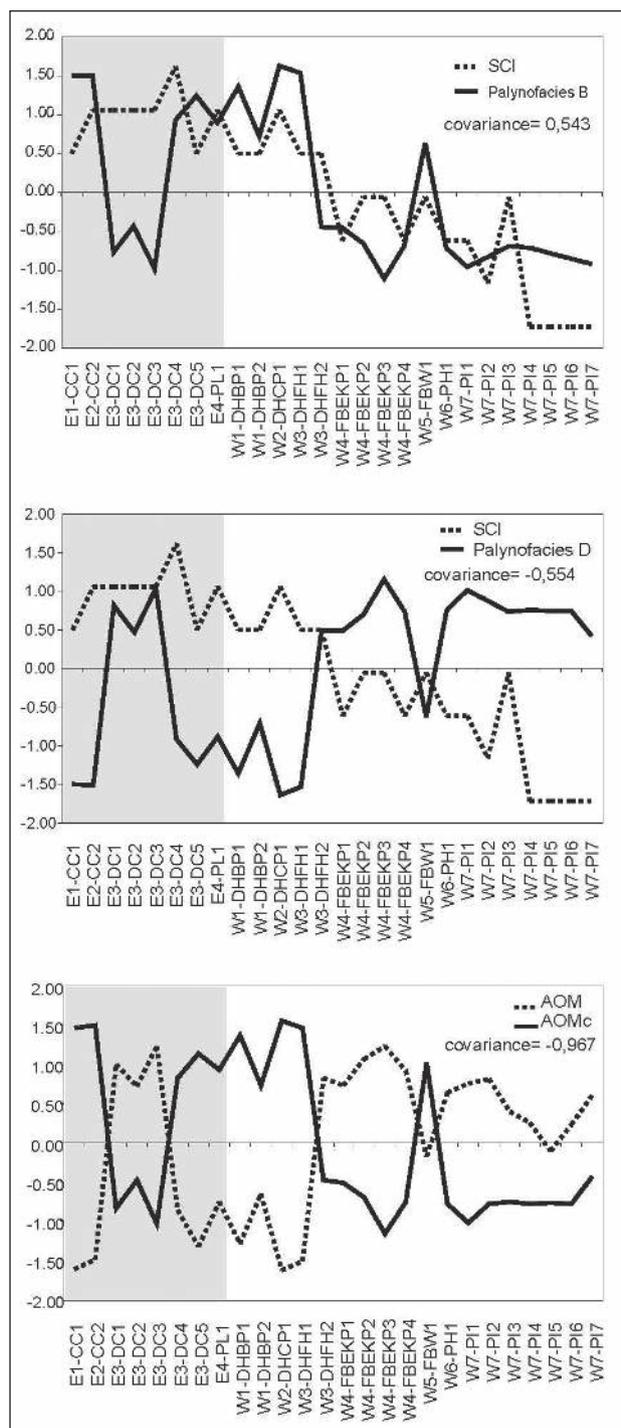


Figure 6 Comparison between the frequency (after normalizations) curves of SCI, Palynofacies A and B and AOM. Grey part of the graphics shows samples from the East Falklands

a transform margin setting. Their study showed the difference of the palynofacies affected by a spreading ridge and by a succeeding passive margin stage.

There was a marked occurrence of darker-colored, non-fluorescing AOM that was derived from degraded plant material instead of degraded marine algae.

## 7 Conclusion

Seven kerogen components were identified: AOM, AOMc, acritarchs, opaque phytoclasts, prasinophycean, *Spongiophyton* and spores. In general, the organic constituents are carbonized.

Four palynofacies can be distinguished in the material. They differ one from the other in proportions of AOM and AOMc. However, the prasinophyceans show moderate abundances.

The presence of marine elements confirms the marine environment; probably the low amount of land derived organic matter is related to the transgressive phase of the transgressive-regressive system.

In West Falkland, the kerogen categories are not completely carbonized as a result of a lesser thermal influence. In East Falkland, the Palynofacies B, represented mainly by AOMc, suggests that East Falkland has been buried to a much deeper depth than West Falkland as consequence of reactivation of the Hornby Mountains anticline (HMA).

## 8 Acknowledgements

We are grateful to the anonymous reviewer, who improved this paper significantly with suggestions and critical comments. We thank Prof. Dr. João Graciano Mendonça Filho coordinator of Laboratory of Palynofacies and Organic Facies of Department of Geology of Federal University of Rio de Janeiro, where the samples were prepared. We would like to express our thanks to Prof. Dr. Leonardo Borghi for giving us the opportunity to study the samples. We thank especially Maria da Glória Pires de Carvalho (American Museum of Natural History), who kindly for giving us field information.

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