This volume grew out of the various oral and poster presentations given during the ‘Evaporite’ session at the International Geological Union conference (2004) in Florence, Italy. It was clear that only a few of the participants or attendees, coming from many countries and various distant parts of the world, were well informed about evaporites outside their immediate area of study, apart from data from the most commonly available literature. Diversity in the languages of publication and the logistical difficulty of making first-hand comparisons acts as a major barrier to study. As a result, the basic concept of evaporites that most geologists have is that deposits are the product of simple, chemically controlled environments and, if evaporitic compounds are chemically the same, then it follows that their lithology and origin are also the same. Based on many studies over the past 30 years, it is now clear that this long-held impression is manifestly untrue. The disparities were very evident in the photographic presentations and descriptions at the 2004 International Geological Congress: the same evaporitic compounds can have distinct and diverse lithology, depositional sources and geological history. They cannot be considered to arise solely from simple, direct chemical origins as explained by a single universal model!

In order to make the volume more approachable, we divided the book into five parts: (1) Tectonics, Basin Evolution and Evaporites, (2) Working depositional Models, (3) Post-depositional Evolution of Sediments, (4) Ancient Basins, and (5) Regional Reviews. The first section (five papers) places the formation of evaporite basins and the mechanical behaviour of some evaporites into an observed structural/stratigraphic framework. Karner & Gamboa present the creation and early infilling of the South Atlantic rift basin, while Bertoni & Cartwright address the destabilization and massive reworking of evaporitic sediments into an adjacent ocean basin. Specific tectonic settings with associated depositional styles and stratigraphy are presented in the other three papers in part one, and links tectonics to sedimentary styles. The early and middle Miocene evaporites of Iraq, by Ismail Al-Juboury, Mehdi Al-Tarif & Al-Eisa, and Iran by Rahimpour-Bonab, Shariatinia & Siemann are strongly tied to their rapid geologic evolution. Turner & Sherif, describe a large Triassic–Jurassic basin that stretches across North Africa from Libya to Morocco and its evolution.

The second part of the book (two papers) presents a fairly rigorous treatment of evaporitic water-body behaviour with associated sedimentation. The first paper, by Babel, is based on the observed sedimentary section from the middle Miocene of the Carpathian foredeep, and addresses the problem of how evaporite deposition is controlled by water stratification, circulation and mixing. The second paper, by Lopez & Mandado, deals with an observed opportunity to become acquainted with those evaporites. The second additional paper is also a review, taken from tectonically stable interior basins of North America (the Permian deposits of Texas and New Mexico). This study is in contrast to many other deposits described in this volume as it contains a well-developed, undisturbed basin-fill. As a group, this set of 18 papers gives a good introduction to many diverse environments and styles of deposition and preservation to be found in varied evaporite basins.

example of modern evolution of water in several saline lakes from north-central Spain.

Part three contains only two papers both of which deal with unusual aspects of synsedimentary deformation and then diagenesis within two very different basins. The first is a study by Alberto, Carraro, Giardino & Tiranti that addresses an unusual form of gypsum diagenesis present within some tectonized Triassic evaporites that results in a much altered facies (rauhwacke or ‘pseudo-carnioles’) developed within the original evaporite rocks. These truly reveal the complexity caused by both the tectonics and burial/exhumational history of the deposits. The second paper in this section, by Lugli, Dominici, Barone, Costa & Cavozzi, is a geochemical study of the late Miocene (Messinian) Apennine gypsum deposits that considers their deposition in basins which are initially marine-sourced but change over to a largely nonmarine (but concentrated) evolution higher in the stratigraphic section. This observation appears to be valid throughout the late Miocene (Messinian) in many areas of the Mediterranean and may well hold true in other evaporate sequences.

The fourth and largest section of the book (seven papers), presents a series of observation of diverse evaporites ranging in age from the late Miocene to the Neoarchean. The first, another paper on the late Miocene of Italy by Lugli, Bassetti, Manzi, Barbieri, Longinelli & Roveri, discusses isotopic composition and organic matter in the evaporites of the Northern Apennines. Late Miocene geology and stratigraphy of the Southern Apennines is addressed by Matano. Next presented are the middle Miocene gypsum evaporites of the Carpathian region addressed first by Bąbel & Boguckiand then by Bukowski, Czapowski & Karoli. The isotopic composition of the K–Mg sulphates of the same age in one of the Carpathian basins is addressed Hryniv, Parafinuk & Peryt. The next topic treats the origins of some of the Upper Permian (Zechstein) salts of SW Poland as discussed by Vovnyuk & Czapowski. The last paper in this section, by Gandin & Wright, examines deposits from the Neuquén and addresses the elusive products of extreme evaporite diagenesis, where only morphological remnants of evaporites are left.

Finally, in part five of this volume, there are the two regional review papers, describing two amazingly evaporite-rich areas of the world. The first, by Hryniv, Dolishniy, Khmelevska, Poberezhskyy & Vovnyuk, covers a broad overview of the evaporites of Ukraine (Devonian, Permian, Jurassic and Miocene ages). The second, by Hovorka, Holt & Powers, reviews the Permian evaporites of West Texas (Palo Duro, Midland and Delaware basins). Together, these five sections give a fair introduction to the problems faced in evaporite study and some of the necessary answers.

An overview of evaporite puzzles

Elucidating the geological history of evaporites is never straight-forward because evaporite deposits record information in many different ways. Some of the most difficult problems encountered by geologists studying evaporities include realistic assessments of the time intervals of evaporite formation and accumulation, the necessary climatic controls, and the rates of water evaporation/ionic concentration required for evaporite formation. These constraints are presented below, followed by a review of the styles of sedimentation imposed on evaporite formation by differing synsedimentary tectonic histories within the formative basins. It seems that tectonically active and passive basins develop significantly different facies assemblages, as with other types of deposits.

Depositional time intervals in evaporite formation

A feature most evaporites share is that the total depositional time-period for formation and accumulation is very short (even in very thick deposits), so short that the entire deposit may be represented by only one or two biozones in the surrounding area. This means that standard biostratigraphical methods cannot date the evaporite formations precisely and some other high-resolution methods are more useful. For example, Anderson et al. (1972), Richter-Bernburg (1963) and Kirkland (2003), based on isochronous correlation of particular sequences of varves in laminated evaporites, estimated that the late Permian evaporites of both West Texas and the European Zechstein represent deposition over a period of only c. 275,000–300,000 years. Based on the detailed magnetostratigraphic study by Krijgsman et al. (1999), we also know that the late Miocene (Messinian) of the Mediterranean took no more than 600,000 years, and sections of it (0.75–2 km thick) probably took far less time. In many other evaporite basins it is much more difficult to estimate the total time interval precisely due to the lack of significant stratigraphical markers (like ash beds) and, consequently, applicable methodology. It seems that the internal stratigraphy of evaporite formations with well-preserved primary features can be resolved by event stratigraphical techniques, based on key beds that can be correlated over long distances (e.g. Bąbel 2005 a, b). Particularly in shallow-water evaporite settings, event or key beds represent extremely short time intervals, and it seems that the life time of many shallow-water evaporite basins is relatively short (evaporite deposition > accommodation).

Modern depositional rates in shallow water are up to 10 m per 1000 years for halite and
1–2 m per 1000 years for CaSO₄ (Schreiber & Hsu 1980). For ancient, major deep-basin evaporites, we can only estimate their somewhat slower accumulation rates from biostratigraphic estimates because there is no modern working analogue to be taken as a model. In contrast to their marine counterparts, evaporite deposits forming within non-marine basins, particularly those lying within orographic rain shadows (Roe 2005), and in areas of rapid and uninterrupted subsidence may persist for much longer intervals. Their total thickness is largely governed by available accommodation as well as ionic source rates. These very short depositional intervals for thick sediment packages can only take place under strictly constrained environmental conditions, as outlined in the next section.

**Controls on rates of evaporation and ionic concentration**

Kinsman (1976) pointed out that, in order to accumulate thick halite deposits, the regional relative humidity must be low. Kinsman also noted that there is a need for regionally lowered water vapour input, causing a low average relative humidity [less than 76% relative humidity (RH) is needed for halite formation], although this value is only a rough estimate (see Walton 1978). For example, if humidity rises either during the night or seasonally, most of the halite that has been formed will go back into solution and there will be no net accumulation. Dissolved mineral precipitates, such as gypsum and anhydrite, commonly can persist and accumulate, but at less than optimum rates.

Another problem that requires consideration is the decrease in rate of evaporation as ionic concentration (salinity) rises. The evaporation rate of water approaching near-saturation for halite commonly slows, thus it is necessary to have and maintain elevated water temperatures to promote evaporation (particularly to replace energy lost due to evaporation). For example, commercial salt works optimize evaporation conditions by adding a thin layer of new surface water of lower salinity on saline ponds, which insulates the more saline water and also has the effect of heating the water by refracting the infrared (heat) radiation from incoming sunlight back down into the dense bottom waters (heliothermal effect; e.g. Kirkland et al. 1983). By raising the temperature of the water and increasing evaporation, the surface water soon reaches saturation, adding to the original mix. The salt works also keep the surface clear of floating salt that slows down evaporation and they make certain that vigorous phytoplankton blooms of halophilic microorganisms are maintained as their red colour helps to increase water temperature by several degrees (Sammy 1985).

This delicate balance, for both air and water, is not readily maintained for geologically prolonged periods of time (only a few hundreds of thousands of years), except within substantial orographic shadows and deep depressions, where evaporites may form for millions of years. In areas at or near sea level (Brutsaert 1982), as well as above mountainous areas (Nullet & Juvik 1994), evaporation rates have been studied extensively. However, in areas that lie in depressions, well below sea level (possibly like the late Miocene in the Mediterranean), comparatively little is known. Because the lapse-rate for the atmosphere is 6–10°C per kilometre of depression (Brutsaert 1982), the temperatures in deep depressions can become considerably warmer than at sea level or above. The result of this heating is demonstrated in observations of the Dead Sea by Steinhorn (1997), where evaporation proceeds rapidly, forming highly concentrated brines. If, in the past, isolation and drawdown of some large basins such as the late Miocene in the Mediterranean, were even deeper below mean sea level than is the Dead Sea, the temperature and evaporation rates would be higher, despite increased atmospheric pressure. Theoretical calculations by Hay (1996) suggest that descending air could be warmed to more than 50–60°C at the 2 km-deep, near-dry bottom of the Mediterranean depression, highly increasing the evaporation potential, and if this is true, the deposition of K–Mg salts in such an area is quite possible.

**The pycnocline and its effect**

The behaviour of water bodies, particularly those with elevated salinity, is fairly complex. In the paper of Başbel (2007; also Başbel 2005a, b), the following concepts are clearly developed: (1) evaporite deposition and its morphology reflect the stratification in the formative brine column; and (2) evaporative crystallization of various salts is commonly associated with mixing periods in the basin. Başbel (2007) has shown that evaporite facies are linked to the particular stratified water zones in which they form. These zones are separated by a pycnocline (or a boundary between a less saline, diluted and lighter upper water mass, with low ionic concentrations (occasionally undersaturated), and more saline denser bottom brine (permanently oversaturated). In a simplified way, Figure 1 demonstrates the physical conditions potentially established in a water body with elevated salinity. Another major control over deposition is exerted by the pycnocline position and permanence. The known depositional facies within a modern salt works reported by Busson et al. (1982) and Ortí Cabo et al. (1984) yielded enough
information to permit Peryt (1996) to realistically interpret some of the Ukrainian gypsum of the Badenian (facies shown in Fig. 2a & b), which has now been refined and described more fully by Bąbel (2007).

Even the bedding morphology of thick gypsum layers is controlled by the position of the pycnocline (Fig. 3). Massive selenite beds appear ‘truncated’ or flattened when they grow to the level of the pycnocline. Truncation is not caused by mechanical erosion or chemical dissolution, but rather the...
water is less concentrated (undersaturated) above the pycnocline so that the crystals are unable to continue growth above that level. Because a pycnocline is normally horizontal, such flattened surfaces at the tops of selenite beds can be treated as a kind of limiting planation surface (developed subaqueously). This pycnocline boundary is not limited to modern evaporite formation in salinas and saline lakes, but it is readily noted in flattened selenite domes in the primary Messinian gypsum of Sicily (Fig. 3a & b), as well as in the secondary anhydrite (after selenitic gypsum) of the late Silurian in the Michigan Basin (Fig. 3c) and in the Badeonian of the Carpathian foreland (Bąbel 2005a, pp. 18–19, and Pl. 5, fig. 1, marker bed h1).

Styles of deposition in evaporite basins

It is possible to subdivide evaporite-bearing basins according to the stability of the underlying crust because this governs the development of sedimentary facies. There are basins which are developed on the vast continental platforms, showing rigid consolidated crust (tectonically passive basins) characterized by very slow subsidence or uplift with a paucity of seismic shocks, and those which are developed on a mobile substrate with unconsolidated rocks or a dense network of moving tectonic blocks (tectonically active basins) which are characterized by high levels of tectonic activity and rapidity of tectonic movements (faulting, folding and overthrusting). It has become evident that evaporite deposits forming in tectonically calm basins (as in continental interior basins, or failed arms of rifts) may receive a significantly different overall assemblage of depositional facies than those formed in tectonically active basins (as in foredeep portions of foreland basins). Deposits within tectonically calm or passive basins may remain comparatively undeformed (unfolded, undomed or otherwise contorted) after formation. However, those in foredeep or active rift basins are normally both mechanically reworked during deposition and deformed afterwards, so that many of their component parts are distorted and even subjected to low-temperature metamorphism relatively early in their histories. Commonly these deposits also act as the décollement for thrust sheets. These factors make accurate depositional interpretation of evaporites very difficult, but possible with care. In both types of basins the halokinetic effects of uneven loads on salt deposits can obliterate and disturb the primary features, but such tectonic effects are apparently more drastic in active basins.

Evaporites deposited in tectonically active regions (for example, the northern margins of the late Miocene Mediterranean; the middle Miocene Carpathian foredeep) vary greatly in facies development both vertically and laterally across the basin, and even along strike. Added to this complexity is the fact that evaporites are readily slumped, and mechanically

Fig. 3. Control of crystal growth by the position of a pycnocline recorded in flattened tops of many gypsum domes. (a) Primary selenite domes (flattened) in Sicily (late Miocene, Eraclea Minoa). (b) Secondary alabastrine gypsum after primary selenite (flattened domes) in Sicily (late Miocene, Cinciana-Raffadali road). NB. loss of detail is due to replacement of primary selenite by massive alabastrine gypsum, but much of the original structure is still retained. (c) Late Silurian, flattened secondary alabastrine gypsum domes, overlain by bedded, intertidal to subtidal dolomudstone with displacive Ca sulphate nodules: Celotex quarry (Gypsum, IN, USA).
reworked relatively early in their history. Because many evaporites are lithified as they are deposited, they produce large deposits that are solely composed of mechanically reworked materials (Hardie & Eugster 1971; Parea & Ricci Lucchi 1972; Ricci Lucchi 1973; Schreiber et al. 1976; Manzi et al. 2006; Roveri et al. 1998, 2003, 2006a, b).

In contrast to foredeep areas, large-scale syndepositional or early postdepositional mechanical reworking and deformation is rare within most basins developed on stable continental platforms and within abandoned rifts. These evaporites can remain scarcely altered or deformed even over prolonged periods of time (over hundreds of millions of years), unless deeply buried. Because of this, they can retain most of their primary features and morphologies, and commonly their original fluid inclusions (for example, from the USA, Michigan Basin, late Silurian and the Delaware Basin, middle and late Permian). The facies that developed within these deposits vary little laterally, even over considerable distances. Facies diversity is relatively limited throughout most of the section. Examination of very thick evaporite sections (Anderson et al. 1972) or in some basin margins, a well-developed facies multiplicity may be recognizable (Peryt 1996). These latter variations appear to develop in and fill localized sags and irregularities.

In areas where burial of evaporites has been greater than 2–3 km, evaporites may become considerably altered. Gypsum dehydrates to anhydrite commonly by about 1 km depth (0.4 km to more than 4 km depending on many local conditions; Jowett et al. 1993). Below a depth of 3 km halite also may develop significant secondary porosity and permeability (Lewis & Holness 1996). Such secondary porosity was first recognized by Land et al. (1988), especially in halite, fostering alteration. This does not necessarily occur in areas that are tectonically stable but is well developed in regions of elevated fluid pressure due to tectonics or increasing hydrothermal gradient (Hovland et al. 2006a, b).

Facies diversity

The sedimentation within evaporite environments, as observed in deposits from settings such as marine-marginal (sabkha), salina or a relatively shallow subaqueous marine-marginal (1 to perhaps 10 m water), usually serves as a reasonable representation of most of the evaporite facies assemblage found in the rock record (Busson et al. 1982; Ortı Cabo et al. 1984). However, for most large subaqueous basinal deposits, salinas represent only a partial working model because they are restricted to very shallow water bodies; therefore we are obliged to apply the physical conditions known from deeper lakes to model the conditions for many of the other subaqueous facies (Bąbel, this volume; Bąbel & Bogucki, this volume). Naturally, without a good and tested working model, this projection may provide a major source of error. The only certainty is that, once the physical conditions become suitable for evaporite formation, very rapid sediment accumulation results.

Tectonically passive basins

Many thick evaporites (for example, the Michigan Basin and Delaware Basin; see Hovorka et al. this volume) developed in basins located in continental sags or failed arms of ancient rifts, and, based on their chemistry, were largely marine-fed. They were enclosed within a gradually subsiding portion of the continental plate providing accommodation for rapid sediment accumulation under tectonically stable conditions. While the general pattern of pre-evaporite sedimentation is normal in these basins, marked by fauna indicative of open but gradually deepening marine water, the time interval necessary for the evaporite sedimentation is commonly so short that palaeontologists may not even find a ‘break’ in the faunal record between the under- and overlying deposits. This observation has led to the idea that reefs could grow freely in a Silurian sea in which thick evaporites also were forming (Droste & Shaver 1977). There are also reliable sedimentological records that demonstrate intervals of evaporite formation between periods of normal reef growth (pers. comm. 2006, Wm B. Harrison), perhaps precursors to the short and dramatic main interval of evaporite deposition. In more recent sediments (for example the late Miocene of the Mediterranean), establishing stratigraphic controls seems easier, using absolute age dating provided by ash layers and magnetostratigraphy of unaltered sediments, and fossil biostratigraphy. It is evident that the interval of extremely restricted climate is very short. Similarly short time intervals appear to have controlled evaporite deposition for major portions of the thick evaporites in the late Permian Zechstein and the Delaware basins.

There are few facies variations within these passive basins. Within the basin centres, sediments are largely laminar, present as singlets (thin carbonate, admixed with or alternating with a very thin layer of organic matter), couplets (composed of carbonate alternating with anhydrite and/or gypsum at the surface) and triplets (made up of carbonate, anhydrite and then a thin layer of halite). An excellent review of the Castile Formation of the late Permian of the Delaware Basin and its facies
development may be obtained from Kirkland (2003) and Hovorka (2000), but studies in the late Silurian Michigan Basin (Budros 1974; Nurmi & Friedman 1975; Budros & Briggs 1977; Nurmi 1977) and the late Permian of the Zechstein (Richter-Bernburg 1963) also point out this lithology as well. *Lit-par-lit* correlation in such basins is very distinct and extends across most of the deposit. In all of these basins sporadic thicker beds are present, especially in the upper portions of the section. These thicker beds contain pseudomorphic relics of selenitic gypsum, indicative of shallow water facies (Richter-Bernburg 1985; Kendall & Harwood 1989), shown in Figure 4a & b. Some of the shelfal (marginal) deposits also contain these shallow-water facies. This general assemblage of facies is shown in Figure 5.

In limited areas of these basins, at some margins and also in their upper sections, there is a greater variation in facies. This is probably due to inequities in subsidence and/or filling, as well as sea-level fluctuation. In such non-tectonic areas there are few proximal indicators (such as reworked, downslope breccias), but localized buildups of anhydrite do occur adjacent to some reefs and shallow margins. However, most of the deposits in such stable basins are made up of laminites (forming a ‘poker-chip’ facies), sometimes intercalated with a few thicker nodular anhydrite beds that are the relics of layers of selenitic gypsum (Richter-Bernburg 1985, figures 12 & 23; Kendall & Harwood 1989).

A totally different type of facies modification, noted in some basinal evaporites, may come about through seismic effects from very distant regional tectonism, with no evidence of local disruption. Earthquakes or even tsunamis otherwise may have little directly to do with the areas of deposition. Seilacher (1969) and then Bachmann & Aref (2005) have demonstrated that seismic shocks have disrupted thin-bedded soft sediments producing ‘seismites’ in bottom deposits of otherwise calm basins, far from mass-flows, turbidites and other active downslope mechanisms. Comparable deformation and localized brecciation is also noted locally in the Lisan Formation of the Dead Sea (Agnon *et al.* 2006) and possibly in the Castile Formation of West Texas (Permian).

### Tectonically active basins

The distinctly broader facies assemblage found within many active basins is readily seen in the exposed portions of the late Miocene (Messinian) Mediterranean, largely because the evaporites are relatively young and have not undergone burial diagenesis. This basin contains many areas composed of clearly developed, shallow-water evaporite facies, largely formed just below the pycnocline of the basin. There are also a number of large areas with definite deeper-water facies. The 200–250 m thick cyclic gypsum section, correlatable between Spain, Sicily and the Apennines (Italy), required less than 300,000 years for deposition. The climatic/water inflow mechanisms for such rapid deposition have been discussed in numerous papers but most recently Meijer (2006) and Meijer & Krijgsman (2005) have presented interesting and useful models for their formation. The biosтратigraphy of the under- and/or overlying sediments are from well-dated, open marine facies, hence the time intervals are well constrained.

Associated with these shallow-water evaporitive sediments are areas that are a conglomeration of reworked fragments and blocks of primary, shallow water sediments. A comparison of reworked sections between basins shows that these facies are controlled by source areas and the rate and style of reworking. Many sub-basins are partially filled by huge reworked blocks (kilometres in size) that have slid down into basinal muds. Others were broken, slumped and reduced to sands and silts.
Evaporite deposits: what do the lithologic groupings mean?

With the accumulated observations of evaporites available to sedimentologists, there is now enough data available to sort evaporites into meaningful lithological groupings. These groupings are not just based on compositions, trace elements and isotopes, but also on lithology and stratigraphy. The paper presented by Babel & Bogucki (2007, and the references therein) demonstrates the product of the controls exerted by composition, environmental conditions and behaviour of the water that flowed in the Badenian basin(s) more than 11.1 million years ago. These observations are clear enough to draw a realistic model of formation. The general concepts presented step beyond the observations made in modern salinas were reported in Busson et al. (1982) and Ortí Cabo et al. (1984). While Schreiber et al. (1976, 1977) attempted a simplistic environmental reconstruction, the papers in this volume have put primary subaqueous evaporite facies into a stronger and more realistic framework and have pointed the direction of many tectonic and diagenetic changes that are part of the evaporite story. Building on this framework, extending from the clearly understood into the hypothetical, must be done stepwise, incorporating data from other basins. Sedimentation in continental sag-basins, here specifically addressed in
Fig. 6. Facies developed in a tectonically active basin, here in late Miocene evaporite deposits (Tortonian and Messinian), showing mechanically reworked evaporites in an active tectonic setting. (a) Turbidite section (Highway 118, above the ruins of old Gibellina, Sicily), about 40 m in height. Sediment is composed of reworked, shallow-water, primary selenitic gypsum clasts (varying from silts to cobble-sized fragments) plus evaporitic carbonates in an organic-rich matrix (up to 7% organic TOC). Many beds are well sorted and monomineralic while others are very mixed in composition. Outcrop covered by a mesh of protective netting. (b) Sequence of gypsum turbidite beds, containing a considerable siliciclastic, sand component (late Miocene, near la Malaha, Spain (Granada). (c) Irregularly tipped and slid gypsum deposits (shallow-water in origin) in mountain-sized blocks, central Sicily. Bedding is clearly preserved; part of a synsedimentary phase of large-scale downslope reworking, involving the lower beds in the sequence. Messinian, near Raffadali, Sicily (Roveri et al. 2006b). Lines point up the bedding orientation of adjacent blocks. (d) Mass flow at the margin of a long turbidite section near Gibellina, Sicily (Messinian). Composed of evaporative carbonate clasts, large shallow water selenite fragments, and fine sand-size selenite in a gypsiferous argillitic matrix. (e) Coarse, selenite sandstone, part of a turbidite sequence. Crystal fragments contain filamentous, bacterial outlines, indicative of original photic zone growth. Near old Gibellina, Sicily. (f) Close-up of a bedding-plane marked by load casts, at the base of a turbidite layer. Messinian, near old Gibellina, Sicily.
Hovorka et al. 2007 review of the Permian of west Texas, adds to this depositional framework.

Future investigation

In the past 10 years a number of new concepts have been proposed concerning the evolution of seawater composition that may change our view on some of the sources and modes of deposition of evaporite deposits. The idea that mid-ocean ridges can process and modify circulating seawater as it moves through spreading centre magmas and basalts is key to this. Such circulation can change the composition of the world’s oceans over time, but the suggestion is a comparatively new one (Hardie 1996). In addition, a suggestion, presented since the Florence Conference, proposes that large volumes of ‘evaporites’ may actually be due to and form from rift-sourced and hydrothermal fluids (Hovland et al. 2006a, b). This concept certainly must be addressed in the future. Evaporites still represent an uncertain narrative, with further clarity coming slowly as we gain additional information as we learn more about old and new deposits.

In the future, Martian evaporites will increasingly captivate our thoughts, but we will not be able to address those alien deposits until we have a better hold on our Earthly, comparatively modern deposits. Further, if we can make a stab at the meaning of and controls for those evaporites formed on Earth in the Archean, we will be in a far better position to understand off-Earth deposits. This volume about Earth-bound deposits, is a collection of observations, concepts and ideas that can point us toward a fuller understanding of our own world and the many others waiting to be explored.

References


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