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The Biblical Concepts of *Potentia Dei Ordinata* and *Potentia Dei Absoluta* in the Development of Chemistry

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The Biblical Concepts of *Potentia Dei Ordinata* and *Potentia Dei Absoluta* in the Development of Chemistry

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Medieval theologians spoke of the *potentia Dei ordinata* (the power of God expressed in the orderly working of nature) and the *potentia Dei absoluta* (the absolute power of God to intervene miraculously) (Kaiser 1997). Scientific creationists accept this understanding – we believe that God has ordained natural laws that result in a comprehensible natural world. But we recognize God is not bound by natural laws but can act miraculously, as when He spoke the world into existence. This understanding was also foundational not just for the development of science itself. It first appeared outside of the Bible in the Hexameron, a series of lectures on the six days of creation by Basil of Caesarea. Unlike most church fathers, Basil focused on what God communicated through creation itself (Bouteneff 2008). He read Genesis literally and argued for the study of nature to see God's glory. Basil taught that the Lord had created natural laws to govern the normal operation of nature so we could see his greatness in it (Kaiser 1997). This is possibly the first extra-biblical articulation of the *potentia Dei ordinata*.

This concept was fundamental in the establishment of the sciences, including chemistry. Chemistry has its roots in alchemy, which rested on the assumption matter was composed of Aristotle's four elements (fire, earth, air, and water) and supernatural intervention was necessary to alter those elements for transmutation. A key figure in beginning to emphasize the *potentia Dei ordinate* instead was the Christian physician and alchemist Paracelsus. Paracelsus rejected the four elements of Aristotle because he did not find any mention in Genesis of God creating fire. He suggested three principles instead: sulfur, mercury, and salt (Salzeberg 1991). Furthermore, because Jesus had said the sick needed a physician, he concluded that it was unacceptable that physicians of his day were so ineffective. The Lord surely provided the information needed to treat the sick. This set him on a series of experiments that revolutionized medicine and chemistry (Kaiser 1997). Paracelsus did not make a full break from alchemy, he still believed that every organ of the body was empowered by a different spiritual force (Salzeberg 1991) but he was clearly moving the emphasis from the *potentia Dei absoluta* to the *potentia Dei ordinata*.

Probably the best known of Paracelsus' followers was Johan Van Helmont, famous in chemistry for discovering gases. While still believing that there was a separate spirit to every chemical compound, he further developed Paracelsus's emphasis on invoking the *potentia Dei ordinata* to understand chemistry through experiments. Van Helmont rejected Aristotle's 4 elements based on scripture (Genesis simply didn't describe God creating the world from fire, earth, air, and water) but also rejected Paracelsus's 3 principles based on experimental results (Salzeberg 1991). He wrote "I believe nature is the command of God, whereby a thing is that which it is, and doth that which it is commanded to do or act." (Kaiser 1997).

The transition from alchemy to chemistry culminated in Robert Boyle. He greatly respected Van Helmont and so expected to find spiritual forces in the movement of gases. But experiments led him to conclude it was not necessary to invoke *potentia Dei absoluta* to explain chemical behavior. Gas molecules behaved as they did due to natural laws God had ordained to govern them. He did not see this as detracting from God's glory but rather emphasized His role as Creator and sustainer of an orderly world (Kaiser 1997). God was capable of intervening miraculously but generally He is glorified in creation through the *potentia Dei ordinata*. This was the understanding of Basil and is that of creationists today. Rather than being a modern aberration, the creationist view was foundational for the development of science, as illustrated by the history of chemistry.

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Lithostratigraphic Correlation of the Coconino Sandstone (Permian) and Its Equivalents, Western United States

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The purpose of this study was to correlate Upper Paleozoic sandstone bodies of Pennsylvanian and Permian ages across the western United States. The cross-bedded Coconino Sandstone (Arizona) is perhaps one of the best-known formations in this collection of sandstones, many of which contain large cross-beds and thus are often interpreted as eolian in origin (McKee and Bigarella 1979). The Coconino Sandstone (Leonardian) is found in northern Arizona in places like Sedona and Grand Canyon.

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Stratigraphic columns were obtained from multiple sources including the AAPG's COSUNA charts and data, the RMAG's *Geological Atlas of the Rocky Mountain Region*, and published papers from a variety of books and journals (Adler 1986; Ballard et al. 1983; Bergstrom and Morey 1984; Hintze 1985, 1988; Hills and Kottlowski 1983; Kent et al. 1988; Mankin 1986; Mallory 1972a, 1972b). About 60 generalized stratigraphic columns were collected, drawn and then correlated across the western United States. North American Chronostratigraphic Units were used for this study since virtually all the Permian and Pennsylvanian literature for the western United States uses this nomenclature. Columns were "hung" on the Pennsylvanian/Permian boundary. Four sections were correlated from southern to northern states. Some of the better-known sandstones and formations included in this study were the Casper (WY), Cedar Mesa (UT), Coconino (AZ), Cutler (UT), De Chelly (AZ), Esplanade (AZ), Glorieta (NM, OK, TX), Lyons (CO), Minnelusa (MT, WY), Quadrant (MT), Queantoweap (UT), Tensleep (MT, WY), Weber (UT) and White Rim (UT). These sandstones often do not contain fossils, so many of the correlations were based on lithology, presumed age and distinctive units above and/or below the sand bodies of interest (such as limestone, salt, gypsum and phosphorite deposits).

It was found equivalent sandstones can be correlated on both the eastern and western sides of the Rocky Mountains along transects from California-Arizona-Utah-Idaho-Montana-Dakotas and from California-Arizona-New Mexico-Texas-Oklahoma-Colorado-Wyoming-Nebraska-Dakotas. The sandstone body is diachronous, meaning the northern sandstones were found to be slightly older than the southern ones. When the correlations are examined, it is clear there are large lenses of mud and siltstone within the sandstone bodies (like the Hermit Formation of Grand Canyon). It is estimated that the total area covered by the nearly continuous sand body consisting of all these named sandstones is about 2.0-2.5 million km^2.

The conventional interpretation of the Coconino is that it is an eolian deposit, its cross-beds forming as the result of large migrating desert sand dunes. The outcome of this study is significant because it demonstrates the lithostratigraphic equivalence of the Coconino with other sandstones, some of which are recognized as being marine, which is consistent with other findings indicating a marine origin for the Coconino (Whitmore and Garner 2018). Additionally, it would be hard to conceive of an eolian sand body being continuous around the area of the Ancestral Rocky Mountains (roughly in central and western Colorado); a continuous marine body would be much more plausible.

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