

# The Determination of Gypsum in Soils

## J. Herrero\*

Estación Experimental de Aula Dei  
CSIC  
Ave. Montañana 1005  
50059 Zaragoza  
Spain

## O. Artieda

Univ. de Extremadura  
10600 Plasencia  
Spain

## D.C. Weindorf

Dep. of Plant and Soil Science  
Texas Tech Univ.  
Lubbock, TX 79409

We present the Chapter about the *Soil Gypsum Determination* that appeared in the *Methods of Soil Analysis*, published in an electronic format (available as a pdf or html version) by the Soil Science Society of America.

Growing population and economic development have increased the pressure on soils worldwide, even on those considered marginal years ago because of their high gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) content. Moreover increasing environmental concerns have broadened the interest in gypsum-rich soils beyond the initial, almost exclusive use of soil science in agriculture. Easy and reliable methods for gypsum determination in soils are needed to provide the foundation for ecological and physiological research of gypsophile plants (Palacio et al., 2014; Escudero et al., 2015), microbes (Dong et al., 2007), and in other disciplines where gypsum plays a key role in soil behavior [e.g., for irrigation (Moret-Fernández and Herrero, 2015; Herrero, 2017), or civil engineering (Jha and Sivapullaiah, 2017)].

Gypsum has confounded certain lab determinations in soils, but can be easily determined. A common flaw in the analysis of soils containing gypsum involves drying samples at temperatures  $> 40^\circ\text{C}$ . Under such temperatures, gypsum can release its constitutional water with a total or partial transformation into bassanite ( $\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$ ) and anhydrite ( $\text{CaSO}_4$ ) in unknown proportions. These transformations imply a 16 and 21% loss of the initial gypsum mass, respectively, yet likely go unnoticed when analyzing soils low in gypsum. However, this problem cannot be ignored when analyzing gypsum-rich soils. All further quantitative determinations on this soil with altered mass and composition by any other method, whether wet chemistry or reflectance/fluorescence based, would be distorted; that is, the higher the content of gypsum and drying temperature, the greater the distortion. Distortion is difficult to appraise and may change temporally if the stored soil is exposed to atmospheric moisture, whereby some portion of the de-hydrated sulfates could transform back into gypsum. In soils rife with gypsum, these confounding effects become detrimental to the accuracy of particle size distribution, hydric and other physical properties, salinity, organic carbon, and calcium carbonate because sample weights will refer to an altered soil weight. The transformations of gypsum-bassanite-anhydrite in the atmosphere, driven by temperature, atmospheric water content, and certain other substances were studied over the two past Centuries due to implications for the plaster industry (Herrero et al., 2016). Many researchers have studied the precise temperature of gypsum transformations with no coincident results (Hill, 1937; Herrero et al., 2016). As a precaution, samples should be dried at room temperature. Alternately, if using an oven, drying temperature must not surpass  $40^\circ\text{C}$ .

This chapter of *Soil Analysis Methods* by Herrero et al. (2016) presents and discusses three simple gravimetric and spectroscopic methods for gypsum determination. First they present the Artieda method (Artieda et al., 2006) and second the

## Core Ideas

- We presented in *Methods of Soil Analysis* three easy methods for gypsum determination.
- Two of these methods are gravimetric and only need elementary lab equipment.
- The other method based on portable spectroscopy works in the lab and in the field.

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\*Corresponding author (jhi@eead.csic.es).

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Lebron method (Lebron et al., 2009), both based on measuring different water exchanges between the atmosphere and gypsum. The third presented method (Weindorf et al., 2013) uses the determination of specific chemical elements via portable X-ray fluorescence (XRF) spectroscopy as a proxy for gypsum determination; a key advantage being, this approach is field portable. These three methods use few, if any, chemicals and only rudimentary lab equipment.

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