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Opinion

Thermoanalytical Techniques and Mineral Studies: Interpreting Dolomite's Behaviour

L C Resio[1,2]*

[1]Juan B Justo Lascano Institute of Higher Education, Autonomous City of Buenos Aires, Province of Buenos Aires, Argentina

[2]Faculty of Chemical Engineering, National University of Litoral, Argentina

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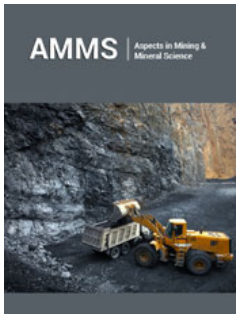

***Corresponding author:** L C Resio, Juan B Justo Lascano Institute of Higher Education, 3840, 1417, Villa del Parque, Autonomous City of Buenos Aires, Province of Buenos Aires and Faculty of Chemical Engineering, National University of Litoral, Santiago del Estero 2829, S3000AOM Santa Fe, Argentina

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Opinion

A thermoanalytical technique is one that measures the physical properties of a substance based on its response to a thermal load [1-2]. In a typical experimental design, a thermal program is run on a known amount of sample, and the material's response to the applied thermal load is observed on a plot created by specific software. There are at least a dozen thermoanalytical techniques, but the most widely used are those that provide chemical (rather than physical) information. Specifically, we are talking about the following techniques: thermogravimetric analysis, differential thermal analysis, differential scanning calorimetry, and microthermal analysis. Among the physical information that thermoanalytical techniques can provide are: crystalline transition, second-order transition, fusion, vaporization, sublimation, absorption, adsorption, and desorption.

Regarding chemical information, we can mention: chemisorption, desolvation (especially dehydration), decomposition, oxidative degradation, solid-state reactions, and solid-gas reactions (e.g., oxidation or reduction) [3]. Among the applications of thermoanalytical techniques in the mining industry, decomposition products and treatment temperatures (in industrial furnaces) are of vital importance. It is known experimentally that thermogravimetry, together with differential thermal analysis, can determine whether the decomposition of a mineral occurs in one or multiple stages, allowing us to infer the appearance of successive and distinct products, which enables the destination and use of each of these products [4-28].

In 2023, I undertook a research project on the thermal behaviour of the dolomitic mineral [29]. To carry out this titanic task (conducting research in Argentina presents significant challenges), I had to conduct an extensive bibliographic review on all the technological aspects of this mineral [30] and a specific review on its thermal behaviour [31]. In this research, I came across various articles that explained that dolomite is a mixture of two carbonate minerals: magnesite and calcite [30]. In relation to this assertion, I have given a discussion with the appropriate experimental justifications [29] and why this statement is not correct. And one of the articles that caught my attention the most is that of Wiedemann & Bayer [32] an older article whose postulate is still valid in the field of mineral chemists, in which they explain that a TGA test carried out in an air atmosphere would show a two-stage process but that the thermogram presents only one signal due to strong overlapping of these signals. This is where I want to focus. This article focuses on analyzing empirical evidence. It questions to what extent researchers should rely on experimental facts versus speculation. Thermoanalytical techniques are complex, primarily because they have proven over the years to be essentially "extensive"

techniques, as Rodriguez-Navarro et al. [33] clarify: the quantities of mass placed in the crucible, the heating rates, and the working atmosphere all influence the plot architecture of the thermogram. That is, there are external physicochemical phenomena (work variables) and internal ones (internal energy, Gibbs free energy, enthalpy, entropy, etc.) that determine the instrument's response, and it is this response that must be interpreted. Like any analytical technique, thermoanalytical techniques can exhibit peak overlap. This overlap should be verified by observing split signals, such as doublets or triplets. From this situation, a peak deconvolution can be decided upon to clarify the thermal phenomenon present. However, interpreting peak overlap based on independent and isolated phenomena assumes that physicochemical phenomena combine in a linear and summative manner, which is not always true.

In summary, when interpreting the signals from the thermograms provided by the different thermoanalytical techniques, it must be taken into account that the kinetic, physicochemical, chemical, and physical factors in the study of solid materials are complex, and their study and understanding are not yet fully clear [34]. Given this framework, the greatest interpretative and scientific rigor must be applied and speculations that only try to force a convenient result for the researcher who simply wants to publish an article must be abandoned.

References

1. Skoog DA, Holler FJ, Crouch SR (2019) Principles of instrumental analysis, Cengage learning.
2. Wiedemann HG, Bayer G (2006) Trends and applications of thermogravimetry. Inorganic and Physical Chemistry pp. 67-140.
3. Coats AW, Redfern JP (1963) Thermogravimetric analysis. A review. Analyst 88(1053): 906-924.
4. Bogahawatta V, Abdul-Jaleel A, Behbehani M (2004) The heat treatment and particle size effects in the thermal decomposition of dolomite for separation of constituents. Mineral Processing and Extractive Metallurgy 113(2): 111-117.
5. Britton H, Gregg S, Winsor G (1952) The calcination of dolomite. Part II-The thermal decomposition of dolomite. Transactions of the Faraday Society 48: 70-75.
6. Caceres PG, Attiogbe EK (1997) Thermal decomposition of dolomite and the extraction of its constituents. Minerals Engineering 10(10): 1165-1176.
7. De Aza AH, Rodríguez MA, Rodríguez JL, De Aza S, Pena P, et al. (2002) Decomposition of dolomite monitored by neutron thermodiffractometry. Journal of the American Ceramic Society 85(4): 881-888.
8. Dollimore D, Dunn J, Lee Y, Penrod B (1994) The decrepitation of dolomite and limestone. Thermochimica Acta 237(1): 125-131.
9. Engler P, Santana MW, Mittleman ML, Balazs D (1989) Non-isothermal, in situ XRD analysis of dolomite decomposition. Thermochimica Acta 140: 67-76.
10. Fang QF, Zhang HW, Guo Y (2011) Thermal decomposition of dolomite. Advanced Materials Research 177: 617-619.
11. Fazeli AR, Tareen JAK (1991) Thermal decomposition of rhombohedral double carbonates of dolomite type. Journal of Thermal Analysis and Calorimetry 37(11-12): 2605-2611.
12. Gunasekaran S, Anbalagan G (2007) Spectroscopic study of phase transitions in dolomite mineral. Journal of Raman Spectroscopy: An International Journal for Original Work in all Aspects of Raman Spectroscopy, Including Higher Order Processes, and also Brillouin and Rayleigh Scattering 38(7): 846-852.
13. Gunasekaran S, Anbalagan G (2007) Thermal decomposition of natural dolomite. Bulletin of Materials Science 30: 339-344.
14. Gupta P, De A (2016) The Effect of composition on the decomposition behaviour of dolomite nuggets. Imperial Journal of Interdisciplinary Research 2(3): 321-324.
15. Haul R, Markus J (1952) On the thermal decomposition of dolomite. IV. Thermogravimetric investigation of the dolomite decomposition. Journal of Applied Chemistry 2(6): 298-306.
16. Kök M, Smykatz-Kloss W (2008) Characterization, correlation and kinetics of dolomite samples as outlined by thermal methods. Journal of Thermal Analysis and Calorimetry 91(2): 565-568.
17. Kristóf-Makó E, Juhász A (1999) The effect of mechanical treatment on the crystal structure and thermal decomposition of dolomite. Thermochimica Acta 342(1-2): 105-114.
18. McCauley R, Johnson L (1991) Decrepitation and thermal decomposition of dolomite. Thermochimica Acta 185(2): 271-282.
19. McIntosh R, Sharp J, Wilburn F (1990) The thermal decomposition of dolomite. Thermochimica Acta 165(2): 281-296.
20. Olszak-Humienik M, Jablonski M (2015) Thermal behavior of natural dolomite. Journal of Thermal Analysis and Calorimetry 119: 2239-2248.
21. Otsuka R (1986) Recent studies on the decomposition of the dolomite group by thermal analysis. Thermochimica Acta 100(1): 69-80.
22. Ptáček P, Šoukal F, Opravil T (2021) Thermal decomposition of ferroan dolomite: A comparative study in nitrogen, carbon dioxide, air and oxygen. Solid State Sciences 122: 106778.
23. Samtani M, Dollimore D, Alexander K (2002) Comparison of dolomite decomposition kinetics with related carbonates and the effect of procedural variables on its kinetic parameters. Thermochimica Acta 392: 135-145.
24. Samtani M, Dollimore D, Wilburn F, Alexander K (2001) Isolation and identification of the intermediate and final products in the thermal decomposition of dolomite in an atmosphere of carbon dioxide. Thermochimica Acta 367: 285-295.
25. Shahraki BK, Mehrabi B, Dabiri R (2009) Thermal behavior of Zefreh dolomite mine (Central Iran). Journal of Mining and Metallurgy, Section B: Metallurgy 45(1): 35-44.
26. Smith JW, Johnson DR, Müller-Vonmoos M (1974) Dolomite for determining atmosphere control in thermal analysis. Thermochimica Acta 8(1-2): 45-56.
27. Subagjo S, Wulandari W, Adinata PM, Fajrin A (2017) Thermal decomposition of dolomite under CO_2-air atmosphere. AIP Conference Proceedings, AIP Publishing.
28. Yener N, Önal M, Üstünışık G, Sarıkaya Y (2007) Thermal behavior of a mineral mixture of sepiolite and dolomite. Journal of Thermal Analysis and Calorimetry 88(3): 813-817.
29. Resio LC (2023) Dolomite thermal behaviour: A proposal to establish a definitive decomposition mechanism in a convective air atmosphere. Open Ceramics 15: 100405.
30. Resio L (2023) Dolomite and dolostone: an approach from geological, ceramic, and refractory perspectives. Tesla Scientific Review 3(2): 237.
31. Resio LC (2024) Dolomite thermal behaviour: A short review. Phys Chem Minerals 51(2): 19.

32. Wiedemann HG, Bayer G (1987) Note on the thermal decomposition of dolomite. Thermochimica Acta 121: 479-485.

33. Rodriguez-Navarro C, Kudlacz K, Ruiz-Agudo E (2012) The mechanism of thermal decomposition of dolomite: New insights from 2D-XRD and TEM analyses. American Mineralogist 97(1): 38-51.

34. Torres García E (2005) Kinetics of thermally activated reactions in solids: An approach. Mexican Petroleum Institute, Mexico.